

RADIOLOGICAL AFFAIRS SUPPORT PROGRAM MANUAL



DISTRIBUTION STATEMENT B: Distribution authorized to U.S. Government agencies only. Other requests for this document must be referred to the Naval Sea Systems Command (SEA-06GN)

PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND



1 OCTOBER 1991

NAVSEA S0420-AA-RAD-010 (RAD-010)

LIST OF EFFECTIVE PAGES

Total number of pages in this publication is 215. consisting of the following:

Page No.	*Change No.	Page No.	*Change No.
Title	0	XIII-1 thru XIII-10	0
Promulgation	0	D-1	0
i thru ix	0	D-2 blank	0
x blank	0	T1-1	0
I-1 thru I-14	0	T1-2 blank	0
II-1 thru II-52	0	T2-1	0
III-1 thru III-17	0	T2-2 blank	0
III-18 blank	0	T3-1 thru T3-6	0
IV-1 thru IV-22	0	T4-1 thru T4-2	0
V-1 thru V-6	0	T5-1 thru T5-2	0
VI-1 thru VI-4	0	T6-1	0
VII-1 thru VII-15	0	T6-2 blank	0
VII-16 blank	0	T7-1	0
VIII-1 thru VIII-6	0	T7-2 blank	0
IX-1 thru IX-18	0	T8-1 thru T8-2	0
X-1 thru X-4	0	T9-1	0
XI-1	0	T9-2 blank	0
XI-2 blank	0	T10-1 thru T10-3	0
XII-1	0	T10-4 blank	0
XII-2 blank	0		

*Zero in this column indicates original page.

NAVSEA S0420-AA-RAD-010 (RAD-010) RADIOLOGICAL AFFAIRS SUPPORT PROGRAM MANUAL



DEPARTMENT OF THE NAVY

NAVAL SEA SYSTEMS COMMAND
7531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5100

IN REPLY REFER TO
5100
Ser 06GN/34
13 APR 1993

From: Commander, Naval Sea Systems Command

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM MANUAL,
NAVSEA S0420-AA-RAD-010 (RAD-010)

Encl: (1) Record of Revisions/Changes

1. This letter promulgates Change 1 to NAVSEA S0420-AA-RAD-010, Radiological Affairs Support Program Manual dated 1 October 1991.

2. Make the following changes:

a. Enclosure (1) is a Record of Revision/Changes and shall be added after the Table of Contents as pages xi and xii.

b. Page I-4, Article 1.2.2, add the following paragraph after the first paragraph:

"Additionally, the Director, Naval Nuclear Propulsion Program maintains regulatory authority over radioactive sources used in direct support of the Naval Nuclear Propulsion Program (i.e., check sources for RADIAC instruments, nuclear instrument test sources, and depleted uranium used as shielding in refueling equipment). Such sources are subject to the requirements of NAVSEA 389-0153 or NAVSEA 389-0288. When these sources are in the custody of a Navy RADIAC Calibration Facility, the requirements of this manual are applicable."

c. Page I-5, Article 2.4, paragraph 2, add to end of the sentence beginning with, "or does it apply to radioactive materials..." the following:

"or, those radioactive sources used in direct support of the Naval Nuclear Propulsion Program as identified in Article 1.2.2 of this manual."

3. The list of effective pages (LOEP) shall be updated by pen and ink changes to reflect Change 1 to the basic instruction.

4. This change is effective upon receipt and shall be retained until publication revision.

R. S. THOMPSON
By Direction



DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, DC 20362-5101

IN REPLY REFER TO

5100
OPR: 06GN
Ser 00/6242
23 Nov 90

From: Commander, Naval Sea Systems Command

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM MANUAL,
NAVSEA S0420-AA-RAD-010 (RAD-010)

1. This letter promulgates NAVSEA S0420-AA-RAD-010, Radiological Affairs Support Program Manual. This Manual establishes radiological controls requirements for the Radiological Affairs Support Program (RASP). The RASP applies to all sources of ionizing radiation within the Navy and Marine Corps except nuclear propulsion, nuclear weapons, and medical-dental sources.
2. This Manual applies the same radiation exposure limits that are used internationally and applies additional controls to carry out the Federal and Navy policies to reduce radiation exposure to personnel to as low as reasonably achievable. This Manual has been reviewed by the Chief of Naval Operations, the Chief, Bureau of Medicine and Surgery, and the Commandant of the Marine Corps.
3. Ships and shore stations shall comply with the standards and procedures of this Manual and maintain effective radiation protection programs for any operation involving RASP ionizing radiation sources. Deviations from the requirements of this Manual are to be submitted to COMNAVSEASYS COM for approval.
4. This letter will be permanently filed as the first page of subject Manual. Further additions to this Manual are planned as noted in various articles and will be promulgated as changes to the basic Manual.


P. M. HEKMAN, JR.

Distribution:
See Page 2

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM

Distribution: (2 copies each unless indicated)

SNDL 21A Fleet Commanders in Chief and Detachment
23C3 Naval Reserve Force Commander
24 Type Commanders
26H Fleet Training Group
26J Fleet Training Unit
26L Polaris Material Office and Detachment
26Q Nuclear Weapons Training Group
26Z Shore Intermediate Maintenance Activity (3 copies)
26GG Explosive Ordnance Disposal Group and Unit
27G COMNAVSUPPFORANTARCTICA only
28A Carrier Group
28B Cruiser-Destroyer Group
28J Combat Logistics Group, Squadron and Support
Squadron
28K Submarine Group and Squadron
28L Amphibious Squadron
29B Aircraft Carrier (CV), (CVN)
31H Amphibious Assault Ship (LHA), (LPH)
31N Multi-Purpose Amphibious Assault Ship (LHD)
32A Destroyer Tender (AD) (3 copies)
32S Repair Ship (AR) (3 copies)
32DD Submarine Tender (AS) (3 copies)
39B Construction Battalion
39C Construction Regiment
39D Mobile Construction Battalion
39F Construction Battalion Detachment
42A Fleet Air Commands
42RR Naval Air Reserve Force
42SS Fleet Maritime Patrol Mobile Maintenance Facility
45A1 Fleet Marine Force
45B Marine Division
45Q Division and Service Support Group and Battalion
46B Aircraft Wing
46C Miscellaneous Aircraft Groups
46M Marine Aviation Logistics Squadron
46P Helicopter Squadrons
A2A CNR only
A3 CNO
A6 CMC
B2A DNA, DLA, NSA, AFRRRI only
B2D DCASR
C20 CNR Detachments (less C20B, C20D, C20F)
C25C INSURV
C31C US Naval Supply Depot Detachment
C31G US Naval Ship Repair Facility Deachment
C34 CINCUSNAVEUR Detachment (less C34E)
C55A NAVMILPERSCOM Detachments
C58J Naval Air Maintenance Training Group Detachments

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM (RASP)

SNDL C79 DIRSSP Detachment
C80 COMNAVAIRSYSCOM Detachment
C81 COMSPAWARSYSCOM Detachment
C82 COMNAVFACEGCOM Detachment
C83 COMNAVSUPSYSCOM Detachment
C84 COMNAVSEASYSYSCOM Detachment
E3A LAB ONR (NRL only 4 copies)
E3C NORDA
FA5 NAF LANT
FA6 NAS LANT
FA7 NAVSTA LANT
FA10 SUBASE LANT
FA13 NAVSUBSUPPFAC LANT (3 copies)
FA18 NAVPHIPBASE
FA22 COMOCEANSYSLANT
FA23 NAVFAC LANT
FA24 NAVBASE LANT
FA27 NAVWPNSFAC LANT
FA30 LANTFLTWPNTAFAC
FA46 PWC LANT
FB6 NAF PAC
FB7 NAS PAC
FB10 NAVSTA PAC
FB13 SUBASE PAC (SUBASE Pearl Harbor only 3 copies)
FB25 NEEACT
FB28 NAVBASE PAC
FB29 NSD (3 copies)
FB30 NAVSHIPREPFAC (3 copies)
FB31 NAVMAG
FB34 COMFLEACT
FB36 NAVFAC PAC
FB38 COMOCEANSYSPAC
FB45 TRIREFFAC (3 copies)
FB54 PWC PAC
FC4 NAF NAVEUR
FC5 NAVSUPPACT
FC7 NAVSTA NAVEUR
FC12 NAVSUPPO
FC14 NAS NAVEUR
FD1 COMNAVOCEANCOM
FD2 NAVOCEANO
FF3 NAVSTA CNO
FF5 NAVSAFECEN
FF8 Inspection and Survey Board
FF38 USNA (3 copies)
FF42 NAVPGSCOL (3 copies)
FH1 COMNAVMECOM
FH3 NAVHOSP
FH14 HSETC

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM (RASP)

SNDL FH26 NAVENVIRHLTHCEN
FH28 NSHS
FH30 NAVMEDCOM REG
FH31 NAVMEDCLINIC
FJA1 COMNAVMILPERSCOM
FKA1 Systems Commands
FKA8F DIRSSP
FKA8F1 ORDTESTU
FKA8F2 NAVPRO
FKA8F3 POMFLANT (3 copies)
FKA8F4 SWF (3 copies)
FKA8F5 SUBASE
FKA11 TRIREFFAC DIRSSP (3 copies)
FKA12 TRITRAFAC DIRSSP
FKM8 NSC CHEATHAM ANNEX
FKM9 NSC (3 copies)
FKM13 SPCC
FKM15 ASO BRASO
FKM17 FLEMATSUPPO
FKM18 NAVMTO
FKM30 NAVRESSO
FKM31 FOSSAC
FKM33 RESALEACT
FKN1 FACENGCOMDIV
FKN2 CBC
FKN3 OICC
FKN7 NEESA
FKN10 NAVSUPPFAC
FKN11 NAVCIVENGLAB
FKP1B WPNSTA
FKP1E NAVUSEAWARENGSTA (3 copies)
FKP1F NAVMINWARENGACT
FKP1G NAVSHIPWPNSYSENGSTA
FKP1J NAVORDSTA
FKP1M NAVWPNSUPPCEN (4 copies)
FKP3 NAVPRO
FKP4B NAVEODTEHCEN (4 copies)
FKP4C NAVORDMISTESTSTA
FKP5A NAVSEACEN
FKP7 NAVSHIPYD (5 copies)
FKP8 SUPSHIP
FKP9 NAVSHIPLO
FKP10 NAVSEASYSOMGTO WESTPAC
FKP16 NAVSSES
FKQ2 NAVELEXSECCEN
FKQ3 NAVELEXCEN, NAVELEXACT (3 copies)
FKQ5 NAVSPASYSACT
FKQ6A NAVAIRDEVCMEN
FKQ6B NAVCOASTSYSCEN
FKQ6C NAVOCEANSYSCEN (4 copies)

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM (RASP)

FKQ6E	DTNSRDC (3 copies)
FKQ6F	NAVSWC (4 copies)
FKQ6G	NUSC
FKQ6H	NAVWPNCEN (4 copies)
FKR1A	NAS NAVAIR
FKR1B	NAVAVNDEPOT (3 copies)
FKR1C	MAD
FKR2	SYSTEMS COMMAND REPRESENTATIVES
FKR3	RDT&E ACTIVITIES NAVAIR
FKR4A	COMPACMISTESTCEN (3 copies)
FKR4B	PACMISRANFAC
FKR5	NAVAVIONICCEN
FKR7	MAINTENANCE ASSISTANCE ACTIVITIES
FM1	COMNAVSECINVCOM
FM2	NAVINVSEVRREGO
FM3	NAVINVSEVR
FR3	NAS COMNAVRESFOR
FR4	NAF COMNAVRESFOR
FR5	NAVAIRES
FR8	NAVAIRLOGOFF
FR18	NAVRESMAINTRAFAC
FT1	CNET
FT2	CNATRA
FT5	CNTECHTRA
FT6	NAS CNET
FT10	NAVAVSCOLSCOM
FT12	NAMTRAGRU
FT13	NATTC
FT15	NAVU CNET (NAVU Chanute AFB only 4 copies)
FT20	NAVCONSTRACEN
FT22	FCTC
FT24	FLETRACEN
FT30	SERVSCOLCOM (SERVSCOMCOM San Diego only 4 copies)
FT31	NTC
FT39	NAVTECHTRACEN
FT45	NAVSCOLEOD
FT51	FLEMINWARTRACEN
FT54	NAVSUBSCOL
FT85	TRITRAFAC CNET
FT89	NAVAIRTU
FT95	SUBTRAFAC
FT104	PWC CNET
V3	COMCAB
V6	CG FOURTH MAW
V7	MATSG
V16	CG MCB
V17	MARCORCAMP ELMORE
V23	CB MCLB (3 copies)
V24	MCRSC
V25	MCAGCC

Subj: RADIOLOGICAL AFFAIRS SUPPORT PROGRAM (RASP)

Copy to: (1 copy each unless indicated)

SNDL	24A1	COMNAVAIRLANT (528.2)
	24A2	COMNAVAIRPAC (7413)
	24D1	COMNAVSURFLANT (N421N)
	24D2	COMNAVSURFPAC (N43A)
	24G1	COMSUBLANT (N442)
	24G2	COMSUBPAC (N423)
	42RR	COMNAVAIRESFOR (57214)
	C84B	NAVSEADET RASO only (100 copies)
	A3	CNO (OP-45) (3 copies)
	A6	CMC (LPO-1)
	FKA1A	COMNAVAIRESYSKOM (54042D)
	FKA1F	COMNAVSUPSYSKOM (06)
	FKA1G	COMNAVSEASYSKOM (06GN) (10 copies)
	FAK1G	COMNAVSEASYSKOM (07)
	FKA1G	COMNAVSEASYSKOM (08)

RADIOLOGICAL AFFAIRS SUPPORT PROGRAM MANUAL
NAVSEA SO420-AA-RAD-010
(RAD-010)

TABLE OF CONTENTS

		PAGE NO.
SECTION I	OCCUPATIONAL RADIATION PROTECTION	
1.1	AUTHORITY AND RESPONSIBILITY FOR RADIATION PROTECTION	I-1
1.1.1	Nuclear Regulatory Commission	I-1
1.1.2	Department of Energy	I-1
1.1.3	Department of Transportation	I-1
1.1.4	Occupational Safety and Health Administration	I-2
1.1.5	Environmental Protection Agency	I-2
1.1.6	National Council on Radiation Protection and Measurements	I-2
1.1.7	International Commission on Radiological Protection	I-3
1.1.8	American National Standards Institute	I-3
1.1.9	International Atomic Energy Agency	I-3
1.2	NAVY DEPARTMENT RADIATION PROTECTION PROGRAM ORGANIZATION	I-3
1.2.1	Bureau of Medicine and Surgery	I-4
1.2.2	Nuclear Propulsion Program	I-4
1.2.3	Nuclear Weapons Radiological Controls Program	I-4
1.2.4	Radiological Affairs Support Program	I-5
1.2.5	Navy Radiation Safety Committee	I-6
1.3	RESPONSIBILITIES	I-6
1.3.1	Chief of Naval Operations (CNO)	I-7
1.3.2	Executive Secretary of the NRSC (OP-455)	I-7
1.3.3	Chief, Bureau of Medicine and Surgery (CHBUMED) ...	I-7
1.3.4	Commander, Naval Sea Systems Command (COMNAVSEASYS COM)	I-8
1.3.5	Commandant of the Marine Corps (CMC)	I-9
1.3.6	Echelon 2 Commanders	I-9

1.3.7	Officer in Charge, NAVSEADET RASO (TECHNICAL SUPPORT CENTER)	I-9
1.3.8	Commanding Officers and Officers in Charge	I-10
1.3.9	RASP Radiation Safety Officers (RSO's)	I-10
1.3.10	Supervisors	I-11
1.3.11	Radiation Workers	I-12
1.4	REQUIRED REFERENCES	I-12
1.5	COMMUNICATIONS, INTERPRETATION, TECHNICAL ASSISTANCE	I-13

SECTION II GENERIC RADIATION PROTECTION ELEMENTS REQUIRED IN ALL LOCAL COMMAND RADIATION CONTROLS PROGRAMS

2.1	RADIATION HEALTH PROGRAM	II-1
2.1.1	Introduction	II-1
2.1.2	Radiation Protection Standards	II-1
2.1.3	Medical Examinations	II-2
2.1.4	Personnel Dosimetry	II-3
2.1.5	Exposure Records	II-3
2.1.6	Radiation Exposure Control for the Unborn Child	II-4
2.2	TRAINING	II-5
2.2.1	Formal Qualification Training for Navy and Marine Corps RASP RSOs and ARSOs	II-5
2.2.2	Formal Radiation Safety Qualification Training for Gamma Radiographers and Radiographers' Assistants	II-7
2.2.3	Formal Radiation Safety Training Requirements for X-Ray Radiographers	II-8
2.2.4	Radiation Safety Qualification Training for Gamma Radiography and X-Ray Radiography Radiation Barrier Monitors	II-9
2.2.5	Radiation Safety Qualification Training for Workers Other than Radiographers and Barrier Monitors	II-10
2.2.6	Radiation Safety Training for Limited Radiation Workers	II-12

2.2.7	Radiation Safety Training for Occupationally Exposed Females and Their Supervisors	II-13
2.2.8	Radiation Safety Training for Emergency Personnel	II-14
2.2.9	Radiation Safety Training for Other Organizational Personnel	II-15
2.2.10	Required Training Record	II-16
2.3	NAVY RADIOACTIVE MATERIALS PERMIT PROGRAM AND NUCLEAR REGULATORY COMMISSION LICENSED RADIOACTIVE MATERIAL	II-17
2.3.1	Navy Radioactive Materials Permits (NRMPs)	II-18
2.3.2	Exemptions	II-19
2.3.3	Termination of Activities Authorized by a NRMP	II-20
2.3.4	Unauthorized Possession or Use of Radioactive Material	II-21
2.4	REPORTING OF EQUIPMENT DEFECTS AND NONCOMPLIANCE FOR NRC LICENSED MATERIAL	II-21
2.5	REGISTRATION OF MACHINE SOURCES OF IONIZING RADIATION (RESERVED)	II-24
2.6	GENERAL RADIOLOGICAL CONTROLS PROCEDURES	II-24
2.6.1	Administrative Control of Occupational Exposure	II-24
2.6.2	Procurement, Inventory and Notification of Persons for Radiation Sources	II-24
2.6.3	Shipment, Receipt, and Opening of Packages	II-25
2.6.4	Labeling, Storage, Posting and Control of Areas	II-26
2.6.5	Radiation Protection Surveys	II-29
2.6.6	Contamination Control	II-29
2.6.7	Control of Airborne Radioactivity	II-31
2.6.8	Protective Clothing and Respiratory Protection	II-31
2.6.9	Leak Testing of Sealed Radiation Sources	II-31
2.6.10	Records and Reports	II-33
2.6.11	Facilities	II-34

2.6.12	Internal Audits and Inspections	II-35
2.6.13	Decommissioning of Facilities	II-36
2.7	SURPLUS RADIOACTIVE MATERIAL PROGRAM (RESERVED)	II-37
2.8	TRANSPORTATION OF RADIOACTIVE MATERIAL	II-37
2.9	RADIATION EMERGENCIES	II-40
2.10	REPORTING OF RADIATION ACCIDENTS AND INCIDENTS	II-41
2.11	FACILITY DESIGN AND SHIELDING REVIEW	II-43
2.12	EXTERNAL AUDITS AND INSPECTIONS	II-47
2.12.1	Notice of RASP Inspections	II-47
2.12.2	Inspection Protocol and Reports	II-48
2.13	CONTRACTOR USE OF NRC LICENSED RADIOACTIVE MATERIAL OR MACHINE SOURCES OF IONIZING RADIATION ON NAVY PROPERTY	II-52

SECTION III GAMMA RADIOGRAPHY

3.1	INDUSTRIAL GAMMA RADIOGRAPHY PROGRAMS	III-1
3.2	NRC REQUIREMENTS FOR CONDUCTING GAMMA RADIOGRAPHY	III-1
3.3	NAVY REQUIREMENTS FOR GAMMA RADIOGRAPHY	III-2
3.3.1	Training and Experience – Fleet Commands	III-3
3.3.2	Training and Experience – Shore Commands	III-4
3.3.3	Dosimetry	III-4
3.3.4	Radiation Surveys	III-7
3.3.5	Internal Radiation Safety Inspections	III-8
3.3.6	Operations Outside of a Permanent Radiographic Installation	III-9
3.3.7	Permanent Radiographic Installations	III-11
3.3.8	Procurement and Receipt of Radiography Sources	III-13

3.3.9	Records and Reports	III-14
SECTION IV X-RAY RADIOGRAPHY		
4.1	GENERAL	IV-1
4.2	GENERIC REQUIREMENTS FOR CONDUCTING RASP X-RAY RADIOGRAPHY	IV-1
4.3	EXEMPT SHIELDED FACILITIES	IV-3
4.3.1	Physical Requirements	IV-3
4.3.2	Operational Requirements	IV-4
4.4	SHIELDED FACILITIES	IV-5
4.4.1	Physical Requirements	IV-5
4.4.2	Operational Requirements	IV-6
4.5	OPEN FACILITIES	IV-6
4.5.1	Physical Requirements	IV-6
4.5.2	Operational Requirements	IV-7
4.5.3	Flight Deck or Hangar Deck Requirements	IV-9
4.6	SURVEY INSTRUMENTS AND PERSONNEL DOSIMETRY	IV-9
4.6.1	Radiation Survey Instruments	IV-9
4.6.2	Pocket Dosimeters	IV-10
4.6.3	Primary Personnel Dosimeters	IV-12
4.7	RADIATION SAFETY OPERATING AND EMERGENCY PROCEDURES	IV-13
4.8	RADIATION PROTECTION INSPECTIONS AND SURVEYS	IV-14
4.8.1	Radiation Protection Inspections	IV-14
4.8.2	Radiation Protection Surveys	IV-16
4.9	LOGS AND RECORDS	IV-18
4.9.1	Pocket Dosimeter Logs	IV-18
4.9.2	Utilization Logs	IV-18
4.9.3	Radiation Survey Instrument and Pocket Dosimeter Calibration Records	IV-20
4.9.4	Initial Facility Evaluations or Facility Re-evaluations	IV-20
4.9.5	Radiation Protection Surveys and Inspections	IV-21

4.9.6	RASP Inspection Records	IV-21
4.9.7	Training	IV-21
4.10	REPORT REQUIREMENTS	IV-21

SECTION V SHORE RADIAC REPAIR FACILITY OPERATIONS

5.1	RESPONSIBILITIES	V-1
5.1.1	RASP Radiation Safety Officer (RSO)	V-1
5.1.2	Senior RADIAC Calibration Technician and RADIAC Calibration Laboratory Supervisor	V-1
5.2	TRAINING	V-2
5.3	RADIATION SURVEYS	V-2
5.4	SOURCE INVENTORY, INSPECTION AND MAINTENANCE	V-3
5.5	RECEIPT, SURVEY AND DECONTAMINATION OF RADIACs	V-4
5.6	PERSONNEL DOSIMETRY	V-5
5.7	OPERATING AND EMERGENCY PROCEDURES	V-6
5.8	SOURCE LEAK TESTS	V-6

SECTION VI RADIOACTIVE MATERIALS REMOVAL PROGRAMS

6.1	PERSONNEL PROTECTION	VI-1
6.1.1	Isotopes and Associated Hazards	VI-1
6.1.2	Personnel Protection Equipment	VI-1
6.1.3	Medical Exams and Bioassays	VI-2
6.1.4	Personnel Monitoring	VI-2
6.1.5	Personnel Training	VI-3
6.2	INACTIVE SHIPS PROGRAM	VI-3
6.2.1	Introduction	VI-3
6.2.2	RADIACs	VI-3
6.2.3	Radiation Level and Contamination Criteria	VI-4
6.2.4	Removal, Packaging and Transportation	VI-4
6.2.5	Cannibalization	VI-4

SECTION VII RADIOACTIVE COMMODITIES WITHIN THE NAVAL SUPPLY SYSTEM

7.1	GENERAL	VII-1
7.2	RESPONSIBILITIES	VII-2
7.2.1	Commanders of Supply Facilities	VII-2
7.2.2	Radiation Safety Officers	VII-3
7.3	COMMODITIES CONTAINING RADIOACTIVE MATERIAL	VII-4
7.4	PROTECTION OF PERSONNEL HANDLING RADIOACTIVE COMMODITIES	VII-5
7.5	RADIOLOGICAL CONTROLS PRACTICES AND PROCEDURES	VII-6
7.5.1	Administrative Controls	VII-6
7.5.2	Storage Areas	VII-7
7.5.3	Fire Protection Practices	VII-8
7.5.4	Contamination Control	VII-8
7.5.5	Storage of Calibration and Test Sources	VII-9
7.5.6	Radiation Surveys	VII-9
7.5.7	Surplus Radioactive Commodities	VII-10
7.6	TRANSSHIPMENT OF NRC LICENSED RADIOACTIVE MATERIAL	VII-10
7.6.1	Receipt	VII-11
7.6.2	Receipt Surveys	VII-11
7.6.3	Storage	VII-12
7.6.4	Shipment	VII-13
7.6.5	Gamma Radiography Additional Precautions	VII-13
7.7	EMERGENCY ACTIONS AND PROCEDURES	VII-13

SECTION VIII TYPE A PERMITS OF BROAD SCOPE

8.1	TYPE A BROAD SCOPE PERMIT CONDITIONS	VIII-1
8.2	ORGANIZATION	VIII-1
8.3	SAFETY EVALUATIONS FOR USE OF RADIATION SOURCES	VIII-4
8.4	ADMINISTRATIVE CONTROLS	VIII-5

SECTION IX OTHER MACHINES PRODUCING IONIZING RADIATION

9.1	ELECTRON ACCELERATORS	IX-1
9.1.1	Radiation Safety Requirements for Electron Accelerators	IX-1
9.1.2	Area Controls	IX-1
9.1.3	Electron Accelerator Controls and Interlock Systems	IX-2
9.1.4	Warning Devices and Area Radiation Monitors	IX-2
9.1.5	Operations	IX-3
9.1.6	Radiation Survey Instruments	IX-4
9.1.7	Personnel Dosimetry	IX-4
9.1.8	Radiation Protection Surveys	IX-6
9.1.9	Special Considerations for Electron Accelerators with Energies Exceeding 10 MeV	IX-7
9.1.10	Logs and Records	IX-8
9.2	ELECTRON BEAM WELDERS	IX-10
9.3	KLYSTRON AND CATHODE RAY TUBES	IX-10
9.4	RADIATION SAFETY REQUIREMENTS FOR ANALYTICAL X-RAY EQUIPMENT	IX-11
9.4.1	General	IX-11
9.4.2	Open and Enclosed Beam Systems	IX-12
9.4.3	Operations	IX-14
9.4.4	Surveys	IX-15
9.4.5	Records	IX-16
9.5	ELECTRON MICROSCOPES	IX-16

SECTION X SOURCE MATERIAL

10.1	DEPLETED URANIUM	X-1
10.1.1	Depleted Uranium Counterweights	X-1
10.1.2	Depleted Uranium Projectiles	X-2
10.1.3	Other Depleted Uranium Sources	X-3
10.2	THORIUM	X-3
10.2.1	Thoriated Tungsten Welding Rods	X-3
10.2.2	Repair and Processing of Magnesium-Thorium Alloy Manufactured Parts	X-4

SECTION XI SPECIAL NUCLEAR MATERIAL (RESERVED)

SECTION XII OTHER SOURCES OF IONIZING RADIATION

12.1	PORTABLE GAUGES	XII-1
12.2	GAS CHROMATOGRAPHS	XII-1

SECTION XIII GLOSSARY

APPENDICES

A	NRC REGULATORY GUIDE 8.13, REVISION 2, DECEMBER 1987 "INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE"
B	NAVY RADIOACTIVE MATERIALS PERMIT APPLICATION FORM (TO BE PUBLISHED)
C	NAVY CERTIFICATE OF DISPOSITION OF MATERIALS FOR TERMINATION OF NAVY RADIOACTIVE MATERIAL PERMITS (TO BE PUBLISHED)
D	POCKET DOSIMETER LOG

TABLES

1	NATURALLY OCCURRING RADIOACTIVE MATERIALS
2	ACCELERATOR-PRODUCE RADIOACTIVE MATERIALS
3	EXEMPT QUANTITIES
4	ACCEPTABLE SURFACE CONTAMINATION LEVELS
5	TRANSPORTATION REGULATIONS – 49 CFR
6	DETERMINATION OF QUANTITY LIMITS AND PACKAGE SELECTION
7	ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS AND ARTICLES (49 CFR 173.421-425)
8	RASP USAGE CODE INSPECTION FREQUENCIES
9	COMMONLY USED RADIONUCLIDES
10	RADIONUCLIDES IN NSN-NUMBERED COMMODITIES

BLANK

RECORD OF REVISIONS/CHANGES

REVISION/CHANGE NO.	DATE ENTERED	ENTERED BY
Original (OCT. 1991)	XXXXXXXXXXXXXXXXXXXXX	XXXXXX
Change 1 (APR. 1993)		

SECTION I

OCCUPATIONAL RADIATION PROTECTION

1.1 AUTHORITY AND RESPONSIBILITY FOR RADIATION PROTECTION

The use of radioactive material and machines emitting ionizing radiation is subject to guidance, recommendations and regulations from a multitude of agencies. The more important of these will be briefly discussed in this section.

1.1.1 NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission (NRC) regulates the use of byproduct material, special nuclear material and source material. Byproduct material is produced as a result of the fission process in a nuclear reactor. An example of this is the cesium-137 in the AN/UDM-1A calibration sources used to calibrate RADIAC equipment. Special nuclear material is enriched uranium-235 or plutonium-239. Source material is uranium (excluding special nuclear material), thorium, or the natural ore from which the uranium is extracted. The rules and regulations of the NRC are published in the Code of Federal Regulations (CFR) under Title 10 – Energy, Parts 0–199.

1.1.2 DEPARTMENT OF ENERGY

The Department of Energy (DOE) is the federal agency charged with finding new uses for radioactive material and ionizing radiation. DOE operates the national laboratories and constructs and owns the nuclear weapons in the custody of the armed forces. The rules and regulations of the DOE are published in the Code of Federal Regulations (CFR) under Title 10 – Energy, Parts 200–1099.

1.1.3 DEPARTMENT OF TRANSPORTATION

The Department of Transportation (DOT) has regulatory responsibility for safety in the transportation of all hazardous materials, including radioactive materials. This includes shipments by all modes of transport in interstate or foreign commerce (rail, highway, air, water), and by all means (truck, bus, auto, ocean vessel, airplane, river barge, railcar, etc.), except for postal shipments. Postal shipments come under the jurisdiction of the US Postal Service. The rules and regulations of the DOT are published in the Code of Federal Regulations (CFR) under Title 49 – Transportation.

1.1.4 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

The Occupational Safety and Health Administration (OSHA) sets standards for the protection of employees who use ionizing radiation and radioactive materials in the workplace. Unlike the NRC, OSHA regulations apply to all sources of ionizing radiation and not just byproduct material, special nuclear and source material. The rules and regulations of OSHA are published in the Code of Federal Regulations (CFR) under Title 29 – Labor.

1.1.5 ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for establishing generally applicable environmental standards including those limiting radionuclides in public water supplies and in air emissions. The EPA also advises the President on radiation matters affecting health, including guidance to all Federal agencies in the formulation of radiation standards. Federal agency guidance documents are signed by the President and are published in the Presidential Documents Section of the Federal Register. An example is the Radiation Protection Guidance to Federal Agencies for Occupational Exposure (Federal Register, Vol. 52, No. 17 of 27 Jan 87). The rules and regulations of EPA are published in the Code of Federal Regulations (CFR) under Title 40 – Protection of Environment, Parts 1 – 799.

1.1.6 NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS

The National Council on Radiation Protection and Measurements (NCRP) is a nonprofit corporation chartered by Congress in 1964 to:

1. Collect, analyze, develop, and disseminate information and recommendations concerning protection against radiation, and radiation measurements, quantities and units.
2. Provide a means by which organizations concerned with radiation protection and radiation quantities, units and measurements may cooperate for effective use of their combined resources.
3. Develop basic concepts about radiation quantities, units and measurements, the application of these concepts, and radiation protection.
4. Cooperate with the International Commission on Radiological Protection, the International Commission on Radiation Units and Measurements, and other national

and international organizations, governmental and private, concerned with radiation quantities, units and measurements and radiation protection.

1.1.7 INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

The International Commission on Radiological Protection (ICRP) provides general guidance on the use of radiation sources caused by developments in the field of nuclear energy.

1.1.8 AMERICAN NATIONAL STANDARDS INSTITUTE

The American National Standards Institute (ANSI) publishes American National Standards which are a consensus of members concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not preclude anyone (whether he has approved the standard or not) from manufacturing, marketing, purchasing, or using products, processes or procedures not conforming to the standard.

1.1.9 INTERNATIONAL ATOMIC ENERGY AGENCY

The International Atomic Energy Agency (IAEA) provides for the application of standards of safety for protection against radiation to its own operations and to operations making use of assistance provided by it or with which it is otherwise directly associated. To this end, authorities receiving this assistance are required to observe relevant health and safety measures prescribed by the Agency. The United States is a member of IAEA and subscribes to its regulations in the transport of radioactive materials outside of United States borders and in selling or supplying nuclear materials or expertise to foreign governments.

1.2 NAVY DEPARTMENT RADIATION PROTECTION PROGRAM ORGANIZATION

In SECNAVINST 5100.10F, the Secretary of the Navy (SECNAV) assigned to the Chief of Naval Operations (CNO) the responsibility to establish and manage the Navy Safety and Occupational Safety and Health Program, including the promulgation of appropriate directives, in coordination with the Commandant of the Marine Corps (CMC) for those matters which affect the U.S. Marine Corps.

In OPNAVINST 5100.8G, CNO described and assigned to the Naval Sea Systems Command (NAVSEASYS COM) specific program responsibilities pertaining to ionizing radiation. The Radiological Affairs Support Program (RASP) encompassed in this manual is the responsibility of NAVSEASYS COM (SEA-06GN) and includes all aspects of radiation safety with respect to the design, construction, and control of radiation from x-ray devices, accelerators, radiographic units and from both licensed and non-licensed radioactive materials, including radioactive waste. Excluded are radioactive sources used for medical treatment or diagnosis, radioactivity associated with naval nuclear propulsion and nuclear weapons.

1.2.1 BUREAU OF MEDICINE AND SURGERY

The Chief, Bureau of Medicine and Surgery (CHBUMED) is responsible for the Navy's Radiation Health Program. Guidance for this program is provided in NAVMED P-5055, "Radiation Health Protection Manual". CHBUMED is also responsible for the safety of radioactive sources used in diagnosis or treatment. Per OPNAVINST 6470.3, the Naval Environmental Health Center (NAVENVIRHLTHCEN) acts as the technical support center for the BUMED Radiological Control Program. Guidance for this program is provided by the Head, Radiation Health Branch, BUMED, (MED-212).

1.2.2 NUCLEAR PROPULSION PROGRAM

The Director, Naval Nuclear Propulsion Program (OP-OON) is responsible for the safety of reactors and associated naval nuclear propulsion plants, and the control of radiation and radioactivity associated with nuclear propulsion plant activities. This includes prescribing and enforcing standards and regulations for these areas as they affect the environment and the safety and health of workers, operators and the general public. Accordingly, this manual does not apply to naval nuclear propulsion reactors and associated byproduct radioactivity.

Additionally, the Director, Naval Nuclear Propulsion Program maintains regulatory authority over radioactive sources used in direct support of the Naval Nuclear Propulsion Program (i.e., check sources for RADIAC instruments, nuclear instrument test sources, and depleted uranium used as shielding in refueling equipment). Such sources are subject to the requirements of NAVSEA 389-0153 or NAVSEA 389-0288. When these sources are in the custody of a Navy RADIAC Calibration Facility, the requirements of this manual are applicable.

RASP radiation sources associated with industrial radiography (both gamma and x-ray) and RADIAC instrument calibration at Intermediate Maintenance Activities and naval nuclear shipyards are subject to the requirements of this manual. Other RASP sources at naval nuclear shipyards which are subject to the requirements of this manual include gas chromatographs, analytical measuring instruments (i.e., analytical x-ray and fluorescence analysis devices), electron microscopes and electron beam welders.

1.2.3 NUCLEAR WEAPONS RADIOLOGICAL CONTROLS PROGRAM

The Nuclear Weapons Radiological Controls Program was established by the Chief of Naval Operations (CNO) and remains under his sponsorship (OP-45). CNO further designated Commander, Naval Sea Systems Command (SEA-06GN) as the program manager. The Nuclear Weapons Radiological Controls Program is concerned with radiation exposure received during stowage, maintenance or handling of nuclear weapons and was instituted to verify that radiation exposure to personnel does not exceed established limits and is reduced to a level that is as low as reasonably achievable.

(ALARA). The Nuclear Weapons Radiological Controls Program is not a part of the RASP and therefore is not subject to the requirements of this manual; basic program guidance is provided by the Nuclear Weapons Radiological Controls Manual (NAVSEA TW120-AA-PRO-010).

1.2.4 RADIOLOGICAL AFFAIRS SUPPORT PROGRAM

(Reference: NAVSEAINST 5100.18A)

1.. The Radiological Affairs Support Program (RASP) is the vehicle used by the Commander, Naval Sea Systems Command (COMNAVSEASYSKOM) to discharge his responsibility for radiological controls for the ionizing radiation sources within the scope of this manual. COMNAVSEASYSKOM is the technical manager of the RASP and acts authoritatively on behalf of CNO for all matters under the auspices of the RASP throughout the Navy and Marine Corps.

2. The RASP applies to all ionizing radiation sources including NRC licensed radioactive material, naturally-occurring and accelerator-produced radioactive material, radioactive waste, and machine sources such as x-ray machines, particle accelerators, electron microscopes, laboratory analytical devices and all other equipment capable of producing ionizing radiation. This manual does not apply to radioactive material transferred from DOE to the Department of Defense (DOD) in accordance with Section 91B of the Atomic Energy Act of 1954. Nor does it apply to radioactive materials produced as a consequence of the construction, servicing, operation, or maintenance of naval nuclear propulsion plants. This manual also does not apply to nuclear weapons or sources of ionizing radiation under the auspices of CHBUMED.

3. The RASP is structured as follows:

a. Program management is provided by COMNAVSEASYSKOM. All correspondence concerning RASP policy should be forwarded to the Radiological Controls Program Office (SEA-06GN), addressed to Commander, Naval Sea Systems Command (SEA-06GN), Washington, DC 20362-5101.

b. Technical support, to include radiological assistance, program review, coordination of Navy Radioactive Materials Permits, radiation safety training, and inspection of radiation safety programs is provided by the Naval Sea Systems Command Detachment, Radiological Affairs Support Office (NAVSEADET RASO), Yorktown, VA 23691-5098, message address NAVSEA DET RASO YORKTOWN VA.

c. Radiological Affairs Support Committee (RASC). The RASC is comprised of representatives from the Systems Commands (SYSCOMs), Fleet Commanders (FLTCOMs), Marine Corps, Naval Research Laboratory (NRL), and NAVSEADET RASO.

" , or, those radioactive sources used in direct support of the Naval Nuclear Propulsion Program as identified in Article 1.2.2 of this manual. "

d. Radiological control programs at the SYSCOM, Marine Corps, and FLTCOM level.

e. Radiological control programs in individual ships and stations and at individual Marine Corps commands.

1.2.5 NAVY RADIATION SAFETY COMMITTEE

(Reference: OPNAVINST 6470.3)

1. The Department of the Navy (DON) has been delegated by the NRC, through the issuance of a Master Materials' License, regulatory authority for the receipt, possession, distribution, use, transportation, transfer and disposal of radioactive material at Navy and Marine Corps activities. The Navy Radiation Safety Committee (NRSC) was established by OPNAVINST 6470.3 to provide administrative control of all radioactive material used in the Navy and Marine Corps except for nuclear propulsion reactors and associated radioactivity, nuclear weapons, and certain components of weapons delivery systems. Navy Radioactive Material Permits (NRMPs) are used to maintain this control.

2. MEMBERSHIP. The NRSC shall consist of:

a. Chairman – Director, Environmental Protection, Safety and Occupational Health Division, Office of the Chief of Naval Operations (OP-45).

b. Executive Secretary – Radiation Specialist (NOBC 0847) or Radiation Health Officer (NOBC 0845) assigned as OP-455.

c. A representative from CHBUMED.

d. A representative from COMNAVSEASYSCOM.

e. A representative from Commandant of the Marine Corps (CMC).

f. Additional members shall include representatives with expertise in other professional areas as necessary.

3. NAVSEADET RASO and NAVENVIRHLTHCEN shall serve as technical support centers for the NRSC.

1.3 RESPONSIBILITIES

For convenience, the responsibilities of the various components of the Navy Radiation Protection Program as assigned by OPNAVINST 6470.3 and NAVSEAINST 5100.18A are recapped in Sections 1.3.1 through 1.3.8 below.

1.3.1 CHIEF OF NAVAL OPERATIONS (CNO) (Reference: OPNAVINST 6470.3).

The Navy Radiation Safety Committee (NRSC) acting for CNO shall:

1. Manage the Navy's Master Materials License.
2. Maintain records under this license.
3. Review applications for Navy Radioactive Material Permits (NRMPs) and recommend action to be taken by the Chairman (OP-45) or his designated representative.
4. Meet at least quarterly to review the activities of the Executive Secretary.
5. Maintain a current list of quantities, uses, and locations where radioactive material is received, acquired, possessed, used, or stored.
6. Ensure inspections are conducted to assess compliance with the provisions of the Master Materials License, NRC regulations and of specific NRMPs.
7. Advise Deputy Chief of Naval Operations (DCNO) for Logistics of all non-compliance items with Severity Levels I, II, or III.
8. Provide copies of NRMPs to the NRC.
9. Request additional members from appropriate SYSCOMs when necessary.

1.3.2 EXECUTIVE SECRETARY OF THE NRSC (OP-455)

The Executive Secretary of the NRSC shall:

1. Be responsible for conducting the day-to-day operations and issuing permits approved by the Chairman, NRSC.
2. Serve as the routine point of contact between DON and NRC for all generic and policy matters relating to the Master Materials License.

1.3.3 CHIEF, BUREAU OF MEDICINE AND SURGERY (CHBUMED)

CHBUMED shall:

1. Appoint a member to the Navy Radiation Safety Committee (NRSC).
2. Issue instructions and guidance to medical department activities concerning procedures for obtaining or amending a NRMP.

3. Provide management oversight of NAVENVIRHLTHCEN for the use of radioactive material at medical department activities.

1.3.4 COMMANDER, NAVAL SEA SYSTEMS COMMAND (COMNAVSEASYSCOM)

COMNAVSEASYSCOM shall:

1. Appoint a member to the Navy Radiation Safety Committee (NRSC).
2. Establish and chair the Radiological Affairs Support Committee (RASC) as needed to resolve issues impacting upon industrial radiation safety (NAVSEAINST 5100.18A).
3. Issue instructions and guidance to Navy and Marine Corps activities not under the control of CHBUMED concerning procedures for obtaining or amending a NRMP.
4. Provide management oversight of NAVSEADET RASO for the use of sources of ionizing radiation under the RASP.
5. Direct, coordinate, administer and act authoritatively for CNO in RASP matters. COMNAVSEASYSCOM shall serve as the central point of contact for radiological affairs support within DON.
6. Provide radiological safety training within the Navy to RASP Radiation Safety Officers (RSOs), radiation safety instructors, and others. Act as the central technical review authority for those Navy training programs involved in teaching radiological controls and radiation safety associated with the RASP.
7. Provide all Navy and Marine Corps activities with technical assistance and safety reviews in the establishment, maintenance, and management of effective radiation protection programs.
8. Act as central point of contact with the NRSC to coordinate the administration of NRMPs under the NRC Master Materials License as directed in OPNAVINST 6470.3.
9. Develop a Navy wide system to control RASP radioactive material and devices which emit ionizing radiation.
10. Provide design review of RASP facilities to ensure the adequacy of radiological controls.
11. Inspect radiation protection programs for all RASP activities. Copies of radiation health program deficiencies shall be forwarded to CHBUMED.
12. Develop and maintain a comprehensive procedural directive for the RASP.

13. Provide radiation safety assistance on a nonreimbursable basis, when requested, to all Navy and Marine Corps activities. Services determined to be beyond the scope of available resources may require reimbursement by the requesting command.

14. Act as the Program Manager for the Navy RASP/Medical Radioactive Waste Disposal Program.

1.3.5 COMMANDANT OF THE MARINE CORPS (CMC)

CMC shall:

1. Maintain an effective and unified RASP in coordination with COMNAVSEASYSCOM.

2. Appoint a member to the RASC. The member shall be knowledgeable in Marine Corps Radiological Controls Program and shall function as liaison and central point of contact for radiological affairs with the Marine Corps.

1.3.6 ECHELON 2 COMMANDERS

Echelon 2 Commanders with activities within the RASP shall:

1. Maintain an effective and unified RASP in coordination with COMNAVSEASYSCOM.

2. Appoint member(s) to RASC. The member(s) shall be knowledgeable in the command's radiological protection program and shall function as liaison and central point of contact for radiological affairs. Fleet commanders should consider assigning one representative from each Type Command.

1.3.7 OFFICER IN CHARGE, NAVSEADET RASO (TECHNICAL SUPPORT CENTER)

The Officer in Charge NAVSEADET RASO shall:

1. Serve as Technical Support to the RASP to accomplish NAVSEASYSCOM RASP responsibilities.

2. Serve as a member of the RASC.

3. Provide guidance to Navy and Marine Corps activities in the preparation of requests for NRMPs.

4. Review NRMP requests for completeness and compliance with current regulations.

5. Prepare NRMPs and forward to the NRSC Executive Secretary.

6. Perform inspections to assess compliance with current Navy and Federal regulations and provisions of the specific NRMP.

7. Prepare reports of non-compliance and forward them to the NRSC.

8. Conduct radiation safety training courses.

9. Conduct annual review of Navy training programs involved in teaching radiation safety associated with the RASP.

10. Provide technical assistance as necessary.

1.3.8 COMMANDING OFFICERS AND OFFICERS IN CHARGE

Commanding Officers and Officers in Charge of all naval commands (ashore and afloat) and Marine Corps commands possessing ionizing radiation sources controlled by the RASP which require protection of personnel or the environment shall:

1. Comply with the provisions of this manual and other pertinent Navy directives and federal regulations.

2. Comply with the conditions of specific NRMPs.

3. Comply with the DON policy of maintaining personnel exposure as low as reasonably achievable (ALARA) as cited in OPNAVINST 6470.2 and DODINST 6055.8.

4. Assign, in writing, a qualified RASP Radiation Safety Officer (RSO) and Assistant (or Alternate) Radiation Safety Officer (ARSO) with direct access to the Commanding Officer or Officer in Charge on matters dealing with radiation safety.

5. Establish a Radiological Controls Program and ensure that it is coordinated with the Radiation Health Program by the RSO to provide an effective Radiation Protection Program.

1.3.9 RASP RADIATION SAFETY OFFICERS (RSOs)

RSOs shall:

1. Establish, implement and maintain an effective RASP Radiological Controls Program that complies with the provisions of this manual and other pertinent Navy directives and federal regulations.

2. Provide advice and assistance to all elements of the command or activity on all matters pertaining to RASP radiation safety requirements, procedures, and command policy.

3. Establish liaison with the supporting Radiation Health Officer to coordinate the RASP Radiological Controls and Radiation Health Programs.

4. Perform surveys and inspections as required to ensure compliance with the provisions of this manual and other pertinent Navy directives, specific NRMPs, and federal regulations.

5. Develop, coordinate and participate in training and orientation programs for occupationally exposed individuals, and other personnel as required by this manual.

6. Act authoritatively for the Commanding Officer or Officer in Charge to ensure that radiation protection program deficiencies are corrected expeditiously and that personnel exposure to sources of ionizing radiation are maintained As Low As Reasonably Achievable (ALARA).

7. Maintain current all applicable NRMPs by submitting amendments, renewals, or termination requests in a timely manner.

1.3.10 SUPERVISORS

Supervisors of programs involving sources of ionizing radiation shall:

1. Ensure that operations within their areas of responsibility are conducted in compliance with the provisions of this manual, specific NRMPs, and other pertinent Navy directives and federal regulations.

2. Prepare operating and emergency procedures which ensure compliance with pertinent NRMPs, Navy directives and federal regulations prior to the start of operations involving industrial and analytical x-ray devices, nuclear moisture/density gauges and radioactive material specifically permitted to the end-user.

3. Ensure that employees under their supervision have received the required training in operating and emergency procedures, rules, and special precautions prior to being occupationally exposed to ionizing radiation.

4. Maintain a current ionizing radiation source inventory of all non-exempt sources under their control and a record of their location, and ensure that sources are secured against loss or unauthorized use.

5. Promptly report to the RASP RSO any violation of the provisions of a specific NRMP or pertinent Navy directive or federal requirement; or any accident, significant incident, personnel injury, suspected overexposure, contamination, or internal deposition involving ionizing radiation sources.

1.3.11 RADIATION WORKERS

Radiation workers shall:

1. Obey posted, verbal and written radiological control instructions.
2. Wear dosimetry devices (e.g., thermoluminescent dosimeters (TLDs), pocket dosimeters) as and when required by specific parts of this manual and Chapter 6, NAVMED P-5055, and promptly report any lost or damaged devices to their supervisor.
3. Promptly report to their supervisor or responsible radiation safety personnel any incident, personnel injury, suspected overexposure, contamination, internal deposition, and any suspicious or questionable occurrence involving radiation sources.
4. Be thoroughly familiar with equipment, procedures and the requirement for, and use of, any special devices prior to using or operating any source or device which produces ionizing radiation.
5. Avoid any unnecessary exposure and use the concepts of time, distance and shielding when working in the presence of radiation sources to maintain their exposure As Low As Reasonably Achievable (ALARA).

1.4 REQUIRED REFERENCES

DISCUSSION:

Although this manual is a comprehensive radiation safety document, the following references should be held by the RASP Radiation Safety Officer. They will provide a more complete coverage and discussion. Copies of the Code of Federal Regulations volumes may be purchased from the Superintendent of Documents, Government Printing Office, Washington, DC 20402 (telephone 202-783-3238). Each volume of the code is revised at least once each calendar year. Changes can occur during a year. Subscription services are available from several sources to facilitate maintaining current versions of the CFR. Two sources for obtaining subscription services for various CFR Titles are the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 and Datamation, Inc., P.O. Box 71108, Charleston, SC 29415. Each of the above sources provides a basic copy of the volume and periodic updates as changes occur.

REQUIREMENTS:

1. All NRMP holders shall have on file a copy of each of the following documents:
 - a. Activity Navy Radioactive Material Permit(s) (NRMPs)
 - b. NAVMED P-5055, Radiation Health Protection Manual
 - c. NAVSEA SO420-AA-RAD-010, Radiological Affairs Support Program (RASP) Manual
 - d. OPNAVINST 6470.3, Navy Radiation Safety Committee
 - e. NAVSEAINST 5100.18A, Radiological Affairs Support Program (RASP)
 - f. OPNAVINST 5100.8G, Navy Safety and Occupational Safety and Health Program
 - g. NAVMEDCOMINST 6470.10, Initial Management of Irradiated or Radioactively Contaminated Personnel
 - h. Title 10, Code of Federal Regulations – Energy (for NRC licensed material)
 - i. Title 49, Code of Federal Regulations – Transportation (for those engaged in the transport of radioactive materials)
2. All users of machine sources of ionizing radiation shall have on file a copy of the following documents:
 - a. NAVSEAINST 5100.18A, Radiological Affairs Support Program (RASP)
 - b. NAVSEA SO420-AA-RAD-010, Radiological Affairs Support Program (RASP) Manual
 - c. NAVMED P-5055, Radiation Health Protection Manual
 - d. OPNAVINST 5100.8G, Navy Safety and Occupational Safety and Health Program

1.5 COMMUNICATIONS, INTERPRETATION, TECHNICAL ASSISTANCE

1.5.1 Only written interpretation of requirements in this manual that are provided by NAVSEADET RASO are binding.

1.5.2 All policy issues concerning the RASP and this manual shall be addressed to COMNAVSEASYS COM (SEA-06GN).

1.5.3 Technical issues shall be addressed to NAVSEADET RASO by telephone or in writing.

1.5.4 On-site technical assistance beyond the scope of local resources may be obtained by written request to NAVSEADET RASO via the submitting activity's chain of command.

1. On-site technical assistance is reserved for unique technical issues or for major command radiation controls program deficiencies clearly beyond the training and experience of the command Radiation Safety Officer.

2. The written request should provide as much information as possible concerning the need for technical assistance.

SECTION II
GENERIC RADIATION PROTECTION ELEMENTS
REQUIRED IN ALL LOCAL COMMAND RADIATION CONTROLS
PROGRAMS

2.1 RADIATION HEALTH PROGRAM

2.1.1 INTRODUCTION

DISCUSSION:

The Radiation Health Program is an essential element of any Navy radiation protection effort and includes the areas of medical examinations, radiation protection standards, exposure records and personnel dosimetry. OPNAVINST 6470.2 series assigns responsibility for radiation health to CHBUMED who has issued NAVMED P-5055 (Radiation Health Protection Manual) as the governing document for Navy Radiation Health Programs. Although the Radiation Health Program for any given shore command or organization is administered by the supporting BUMED activity, it is essential for the command Radiation Safety Officer (RSO) to have access to pertinent information contained in the Radiation Health Program, such as records of exposure to ionizing radiation, results of radiation medical examinations, records of special exams and bioassays, and situational and annual reports on personnel exposure to ionizing radiation. It is only through mutual cooperation and the coordinated efforts of radiation health and radiological safety personnel that any command can meet the Navy's goal of maintaining personnel exposure As Low As Reasonably Achievable (ALARA).

Commanding Officers should ensure that the Radiation Health Program and the Radiological Controls Program are coordinated into the Radiation Protection Program at the command level.

2.1.2 RADIATION PROTECTION STANDARDS

DISCUSSION:

The standards for protection of personnel from ionizing radiation associated with the RASP are based on the radiation exposure limits and internal deposition limits of Chapter 4 of NAVMED P-5055. In addition, the Navy has adopted the philosophy of maintaining individual and collective exposures "As Low As Reasonably Achievable" (ALARA). To assist commands in keeping exposures ALARA, the RASP has adopted an administrative control level of 0.5 rem per calendar year. This control level is administrative in nature and applies to radiation workers. To exceed this level requires the written approval of the Commanding Officer.

This requirement is intended not to preclude personnel exceeding 0.5 rem per year, but to provide an administrative review point of individual and command work practices and personnel exposure trends before authorization for individuals to exceed the control level is granted.

REQUIREMENTS:

The radiation protection standards of Chapter 4 of NAVMED P-5055 shall be followed and the following additional requirements apply:

1. The Administrative Control Level of 0.5 rem per calendar year is hereby established for the purpose of reducing the total man-rem from RASP sources of ionizing radiation. Commands may establish lower Administrative Control Levels as desired. If lower levels are established and included in applications for NRMPs, they become binding unless changed by formal permit revision procedures.

2. The Administrative Control Level shall not be exceeded by any individual without prior written approval of that individual's Commanding Officer.

2.1.3 MEDICAL EXAMINATIONS

DISCUSSION:

In accordance with Chapter 2 of NAVMED P-5055, all personnel who are being considered for routine assignment to duties or occupations requiring exposure to ionizing radiation shall be given a medical examination prior to assignment or transfer to those duties. Personnel who are not routinely exposed to ionizing radiation as a result of their normal duties or occupation and are not likely to exceed 0.5 rem per year are not required to have preplacement medical examinations. NAVMED P-5055 gives requirements for subsequent examinations.

REQUIREMENTS:

1. Preplacement and subsequent medical examinations shall be provided to:
 - a. All x-ray and gamma radiographers and radiographers' assistants.
 - b. All personnel whose duties may require entry into a high radiation area (100 mrem or higher in one hour).
 - c. All personnel required by conditions of individual NRMPs.
 - d. All personnel who routinely work with unsealed radium sources containing greater than 0.1 microcuries of radium or with unsealed sources of radioactive material greater than the exempt quantity limits specified in Schedule B of 10 CFR 30.

e. All personnel deemed necessary by the Commanding Officer.

2. The special procedures for internal monitoring listed in Chapter 3 of NAVMED P-5055 shall be requested from the designated supporting medical facility when required by special circumstances associated with occupational exposure.

2.1.4 PERSONNEL DOSIMETRY

DISCUSSION:

Personnel dosimetry provides the means for monitoring and documenting the exposure of radiation workers, evaluating and enhancing ALARA concepts, and ensuring that authorized control levels and limits are not exceeded. It also provides the means for surveillance of individual radiation safety practices and valuable information on exposure trends. For example, the indication of a dose equivalent of 100 mrem for one month on a primary dosimeter is within limits but could well represent unnecessary exposure, the beginning of an individual's departure from good safety practices, or a breakdown in the facility's radiation safety procedures. For the information received from personnel dosimetry devices to be accurate, procedures for handling, storing and wearing the various devices must be followed.

REQUIREMENTS:

1. Personnel requirements for wearing primary dosimetric devices are cited in specific sections of this manual and applicable NRMPs.

2. At no time shall personnel wear only a self-reading pocket dosimeter. It shall be worn with a BUMED approved primary dosimetric device (thermoluminescent dosimeter).

2.1.5 EXPOSURE RECORDS

REQUIREMENTS:

1. Personnel radiation exposure records shall be maintained in accordance with Chapter 5 of NAVMED P-5055.

2. The Command RASP RSO shall review each NAVMED Dosimetry Evaluation Form (NAVMED 6470/1 or 6470/3) and inform RASP personnel of:

- a. Their exposure for the period of the report; and
- b. Their cumulative exposure for the calendar year.

2.1.6 RADIATION EXPOSURE CONTROL FOR THE UNBORN CHILD

DISCUSSION:

The Navy's policy is that particular efforts shall be made to keep radiation exposure to the unborn child as low as practical and that radiation considerations do not prevent assigning women to duties involving exposure to radiation.

The National Council on Radiation Protection and Measurements (NCRP) in Report 91 (Recommendations on Limits for Exposure to Ionizing Radiation) state their position as follows: "The NCRP recommends a total dose equivalent limit (excluding medical exposure) of 0.5 rem for the embryo-fetus. Once a pregnancy becomes known, exposure of the embryo-fetus shall be no greater than 0.05 rem in any month (excluding medical exposure)."

The Nuclear Regulatory Commission took the position that its licensees and contractors "should make particular efforts to keep the radiation exposure of an embryo or fetus to the very lowest practicable level during the entire gestation period as recommended by the National Council on Radiation Protection and Measurements".

CHBUMED has recommended adoption of the NCRP recommendations.

Additional training requirements for personnel are found in Section 2.2.7.

REQUIREMENTS:

1. All reasonable efforts shall be made to keep ionizing radiation exposure to the unborn child to the very lowest practical level.

2. The radiation exposure control level for personnel physically capable of bearing children shall not be extended beyond 0.5 rem per year unless the instruction required by Section 2.2.7 has been repeated and the individual voluntarily signs the statement below. Each extension shall be for no more than 0.5 rem. Additional extensions may be made provided that the Section 2.2.7 training is repeated and the following statement signed again before each extension.

"The recommendations of the National Council on Radiation Protection and Measurements to limit radiation exposure to the unborn child to the very lowest practicable level, not to exceed 0.5 rem during the entire period of pregnancy, have been explained to me. I recognize that protection of the unborn is a joint responsibility of the employer and the employee. I agree

to promptly notify the Radiation Safety Officer if I become pregnant.

Signature _____

Typed or Printed Name _____

Date _____”

3. Once the command is informed of a pregnancy, the command shall take action to limit the exposure to the unborn child to less than 0.5 rem during the entire period of pregnancy. In addition, any exposure received after declaration of pregnancy shall not exceed 50 mrem per month.

4. Female personnel and their supervisors shall be trained on the biological risks to the embryo and fetus from radiation in accordance with Section 2.2.7.

2.2 TRAINING

DISCUSSION:

Commanding Officers of Navy and Marine Corps activities have the responsibility to ensure that occupationally exposed personnel under their jurisdiction maintain exposure to ionizing radiation "As Low As Reasonably Achievable" (ALARA). A part of the ALARA philosophy is the assurance that each person has received radiation safety training commensurate with their potential for occupational exposure to ionizing radiation. There are at least three reasons for radiation safety training. First, the development of worker awareness of radiation safety procedures permits the performance of tasks with greater efficiency and confidence. Second, when individuals are aware that there is some risk associated with their exposure, they can become active participants in the decision to accept and, where possible, to reduce the risk as part of their job. Third, the number and seriousness of accidents and incidents can be reduced through training.

2.2.1 FORMAL QUALIFICATION TRAINING FOR NAVY AND MARINE CORPS RASP RSOs AND ARSOs

DISCUSSION:

The RSO is the key individual in the command for ensuring that radiation safety practices and procedures are followed. The RSO is responsible to the Commanding Officer for all matters relating to ionizing radiation safety.

REQUIREMENTS:

1. INITIAL RSO AND ARSO QUALIFICATION TRAINING

Prior to assuming the duties of command RSO or ARSO, the prospective appointee shall successfully complete initial qualification training at NAVSEADET RASO, Yorktown, Virginia or have equivalent training and experience. Equivalent training and experience will be evaluated on a case-by-case basis by the NRSC prior to appointment as RSO or ARSO. The NRSC has reviewed the position description for the Head, Radiation Health Division (Code 105.5) at Naval Nuclear Shipyards authorized by the Navy Nuclear Propulsion Program and has determined that a person meeting these requirements will also meet the requirements for RSO without additional training (see Note (3)). The following table determines which courses are required based on the sources of ionizing radiation maintained at or used by each command:

RASP RSO AND ARSO TRAINING

<u>SOURCE OF IONIZING RADIATION</u>	<u>REQUIRED COURSE</u>		
	<u>S-4J-0016</u>	<u>S-4J-0020</u>	<u>S-491-0016</u>
Gamma Radiography	X	X	
Neutron Radiography	X		
All Other Radioactive Material Requiring a Navy Radioactive Material Permit	X		
X-Ray Radiography			X
Linear Accelerators	X		
Analytical X-Ray and Electron Microscopes			X

NOTES:

(1) COURSE IDENTIFICATION:

<u>COURSE NO.</u>	<u>COURSE TITLE</u>	<u>DURATION</u>
S-4J-0016	Radiation Safety Officer Course	80 hours
S-491-0016	X-Ray Radiation Safety Officer Course	40 hours
S-4J-0020	Radiographic Safety Training Course	40 hours

Any command needing additional information on the course required for their program should contact NAVSEADET RASO, AUTOVON 953-4692, Commercial (804) 887-4692.

(2) If a command has radiation sources which would require completion of both Courses S-4J-0016 and S-491-0016, then only Course S-4J-0016 is required as it incorporates the radiation safety training of Course S-491-0016.

(3) For gamma radiography, if the RSO does not have at least one year of experience as a qualified radiographer, an individual with this experience shall be assigned responsibility for the day-to-day supervision of the gamma radiography program.

(4) Course S-4J-0020 is offered only for fleet RSOs and ARSOs.

2.2.2 FORMAL RADIATION SAFETY QUALIFICATION TRAINING FOR GAMMA RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

DISCUSSION:

Gamma radiographers and radiographers' assistants are charged with controlling a source of ionizing radiation which has a potential for serious exposures to themselves and members of the general public if radiation safety practices are violated or ignored. Because of this potential, it is incumbent upon each command engaged in gamma radiography to ensure that radiation safety training is effective and in strict compliance with 10 CFR 34 requirements and specific conditions of their NRMP.

REQUIREMENTS:

1. INITIAL TRAINING

a. **MILITARY GAMMA RADIOGRAPHERS.** Each military gamma radiographer shall successfully complete the Radiographic Operator Course (A-701-0032) at Service Schools Command, San Diego, California. This course provides the radiation safety training specified by 10 CFR 34, Appendix A. All training shall be documented.

b. **CIVILIAN GAMMA RADIOGRAPHERS.** Civilian radiographers at Navy activities shall successfully complete the radiation safety training specified and described in their individual application for a NRMP to conduct gamma radiography. These courses shall provide the radiation safety training specified by 10 CFR 34, Appendix A. All training shall be documented.

2. **LOCAL COMMAND TRAINING.** All gamma radiographers and radiographers' assistants shall receive training in local command operating and emergency procedures. All training shall be documented.

3. **PERIODIC TRAINING.** All gamma radiographers and radiographers' assistants shall successfully complete annual refresher training in radiation safety procedures and regulations specified and described in their individual command applications for a NRMP to conduct gamma radiography. All training shall be documented.

2.2.3 FORMAL RADIATION SAFETY TRAINING REQUIREMENTS FOR X-RAY RADIOGRAPHERS

DISCUSSION:

Unlike gamma radiography, there are no federal controls on training and qualification of x-ray radiographers. Thus, it is incumbent upon the Navy and Marine Corps RASP to establish minimum requirements which ensure that x-ray radiographers have undergone sufficient training to safely operate industrial x-ray equipment. Each command which operates industrial x-ray equipment must ensure that required radiation safety training programs are complete and effective.

REQUIREMENTS:

1. **INITIAL TRAINING.** Each x-ray radiographer shall successfully complete one of the following courses which shall be documented:

a. NDI Technician Course (C-603-3191) presented by Naval Unit, Chanute Air Force Base, Rantoul, Illinois.

b. Radiographic Operator Course (A-701-0032) presented by Service Schools Command, San Diego, California.

c. A local command sponsored course which has written approval of the radiation safety content from NAVSEADET RASO.

d. A commercial company course for which the curriculum has been reviewed for radiation safety content and approved by NAVSEADET RASO.

2. PERIODIC TRAINING

a. Commands performing x-ray radiography shall provide each x-ray radiographer with at least six hours of annual refresher training which includes, as a minimum, the following subjects. Successful completion of this training shall be demonstrated by the student attaining a score of 70% or higher on a written examination.

- (1) Command x-ray radiography operating and emergency procedures.
- (2) RADIAC survey equipment requirements and operation.
- (3) Personnel dosimetry requirements.
- (4) Responsibilities of radiography and radiation safety key personnel.
- (5) Maintenance of required records.
- (6) Relative risk associated with exposure to ionizing radiation.
- (7) X-ray radiography accident case histories.
- (8) Local procedures for maintaining personnel exposures As Low As Reasonably Achievable (ALARA).
- (9) Requirements of Section IV (x-ray radiography) of this manual.

b. In addition to annual refresher training on the above subjects, training shall be conducted and documented each time there is a substantive change in equipment or operating procedures.

c. Periodic training shall be conducted by the RSO or his designated representative or both and shall be documented.

2.2.4 RADIATION SAFETY QUALIFICATION TRAINING FOR GAMMA RADIOGRAPHY AND X-RAY RADIOGRAPHY RADIATION BARRIER MONITORS

REQUIREMENTS:

1. INITIAL TRAINING. Prior to assignment as barrier monitors, personnel shall receive initial training in the following areas. Successful completion of this training shall be demonstrated by the student attaining a score of 70% or higher on a written examination. All training shall be documented.

- a. RADIAC survey instrument operation.
- b. Barrier survey techniques.
- c. Radiation exposure standards for radiation barriers.
- d. Requirement to keep personnel from crossing barriers into radiation areas, except during emergencies.

e. Requirement for and methods of communications with the radiographer during operations.

f. Principles and operation of personnel dosimeters.

g. Relative risk associated with exposure to ionizing radiation.

2. PERIODIC TRAINING. Those personnel designated as barrier monitors shall receive annual refresher training on the topics listed above. The duration of the training shall be determined by the command RSO. This training shall be conducted by the RSO or a designated representative and shall be documented.

2.2.5 RADIATION SAFETY QUALIFICATION TRAINING FOR WORKERS OTHER THAN RADIOGRAPHERS AND BARRIER MONITORS

DISCUSSION:

The scope of radiation safety training for various workers should be essentially the same for all commands despite the wide variance in types of sources and potential hazards. The depth of the material will be the main variant. It is incumbent upon commands to ensure that their initial training contains sufficient depth of the material to ensure that personnel are aware of the radiation safety requirements and procedures to maintain exposures ALARA and reduce the potential exposure and radioactive contamination. For the RASP program the hierarchy of personnel includes:

1. Radiation Workers (occupationally exposed, requires physical examination, work is performed in controlled areas and duties routinely involve exposure to radiation). Examples include x-ray and gamma industrial radiographers, radiation calibration laboratory technicians, operators of analytical x-ray equipment, and users of nuclear moisture density meters.

2. Limited Radiation Workers (not exposed to ionizing radiation on a routine basis, physical examination not required, sporadic exposure monitored). Examples include maintenance personnel, delivery personnel, messengers, fire and emergency response personnel and inspectors.

3. Other Organizational Personnel (indirect and sporadic exposure, individual monitoring not required, environmental controls established to insure that annual exposure does not exceed 500 mrem, physical examinations not required). Examples include persons working in areas adjacent to restricted areas or radioactive materials storage areas, persons working with exempt quantities of radioactive materials or using or working in the vicinity of equipment established to be inherently safe or containing insignificant quantities of radioactive material such as gas chromatographs and electron beam welders.

REQUIREMENTS:

1. INITIAL TRAINING FOR RADIATION WORKERS

a. Each radiation worker shall, prior to performing any radiation duties, successfully complete radiation safety training including the following topics as a minimum. Successful completion of this training shall be demonstrated by the individual attaining a minimum score of 70% on a written examination.

(1) Operating, maintenance, handling and accountability procedures for the devices or radioactive sources in use (including command specific operating procedures).

(2) Radiation exposure limits and control levels.

(3) Specific RADIAC survey instrument requirements and operating procedures.

(4) Facility or site survey requirements and procedures (if applicable to duties).

(5) Specific personnel dosimetry requirements.

(6) Biological effects and risks associated with exposure to ionizing radiation.

(7) Types and sources of ionizing radiation contributing to personnel exposure (alpha, beta, gamma, x-ray, neutron, and internal or external exposure).

(8) Specific procedures for using time, distance and shielding to maintain individual exposures ALARA.

(9) Responsibility of individuals.

(10) Emergency procedures.

b. Initial training shall be a minimum of eight hours in duration. Commands with numerous radioactive devices or radiation producing machines should expand the scope and duration of their initial training accordingly. Initial training shall be conducted by the RSO or a designated representative and shall be documented.

2. PERIODIC TRAINING

a. Each radiation worker shall receive annual refresher training covering the following topics, as a minimum:

- (1) Command radiation safety operating and emergency procedures.
- (2) Use of RADIAC survey instruments.
- (3) Personnel dosimetry.
- (4) Results of internal audits and inspections.
- (5) Command conducted radiation survey results and personnel exposure trends.

- (6) How and why to maintain exposures ALARA.

b. This periodic training shall be a minimum of four hours in duration and longer at commands with numerous sources or machines. Periodic training shall be conducted by the RSO or a designated representative and shall be documented.

2.2.6 RADIATION SAFETY TRAINING FOR LIMITED RADIATION WORKERS

DISCUSSION:

Radiation safety training for limited radiation workers should be specific to the areas and hazards that the individual could reasonably encounter.

REQUIREMENTS:

1. INITIAL TRAINING

a. Each limited radiation worker shall receive initial training on the following minimum topics:

- (1) Sources of radiation in areas they may frequent.
- (2) Potential hazards associated with radiation sources in areas they may enter.
- (3) Use and meaning of radiation warning signs and barriers.
- (4) Procedures to avoid and reduce exposures.
- (5) Personnel dosimetry requirements.

b. The duration of this initial training shall be locally determined, and it shall be conducted by the RSO or a designated representative, and documented.

2. PERIODIC TRAINING. Each limited radiation worker shall annually receive documented training covering the scope of the initial training requirement. Periodic training shall be conducted by the RSO or a designated representative and be documented.

2.2.7 RADIATION SAFETY TRAINING FOR OCCUPATIONALLY EXPOSED FEMALES AND THEIR SUPERVISORS

DISCUSSION:

Exposure of a female worker to penetrating radiation may also involve exposure of an embryo or fetus. Because a number of studies have indicated that the embryo or fetus is more sensitive to ionizing radiation than an adult, particularly during the first three months after conception, the National Council on Radiation Protection and Measurements (NCRP) recommended in its Report No. 91 that special precautions be taken to limit exposure when an occupationally exposed woman could be pregnant.

RASP commands should provide training to occupationally exposed females and their supervisors regarding the nature of the potential risk to the embryo or fetus from the female's occupational exposure.

REQUIREMENTS:

1. Prior to being issued dosimetry equipment, all personnel authorized to receive radiation exposure shall be given specific instruction about prenatal exposure risks to the developing embryo and fetus. Instruction, including the requirements of Section 2.1.6 and applicable information in Appendix A to this manual, and U.S. Nuclear Regulatory Commission Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure", shall be given.

2. Instruction concerning prenatal exposure to the unborn child shall also be given to personnel who supervise female workers authorized as above, because such personnel affect the amount of radiation exposure a female worker receives.

3. Instruction concerning prenatal exposure to the unborn child shall be given during initial and annual training.

4. All female personnel receiving instruction in accordance with this paragraph shall sign the following statement prior to being issued dosimetry equipment:

"The recommendations of the National Council on
Radiation Protection and Measurements to limit

radiation exposure to the unborn child to the very lowest practicable level, not to exceed 0.5 rem during the entire period of pregnancy, have been explained to me.

Signature _____

Type or Printed Name _____

Date _____

The signed statements shall be kept with the training records required in Section 2.2.10. Statements signed by visitors shall be retained for three years.

5. Any directives on exposure limits for the unborn child that are in addition to this manual and U.S. NRC Regulatory Guide 8.13 shall not be used unless prior approval is obtained from Naval Sea Systems Command (SEA-06GN). Because of the signed statement required above from personnel who receive this training, questions on this subject in written examinations are unnecessary and inappropriate.

6. The training shall be conducted by the RSO or a designated representative and shall be documented.

2.2.8 RADIATION SAFETY TRAINING FOR EMERGENCY PERSONNEL

DISCUSSION:

Firefighting, security and other personnel who, in response to an emergency situation, may be required to enter areas where they could be exposed to ionizing radiation sources or devices should receive initial and periodic training on how to protect themselves from the hazards involved. However, emergency personnel should understand the relative priority of radiological controls versus other safety considerations. Firefighters, for example, should be trained that when fighting a fire that involves radioactivity, the fire is, in most cases, more of a threat to life and property than radiation exposure, and that radiological controls shall not be instituted that significantly impair the firefighting effectiveness.

REQUIREMENTS:

1. INITIAL TRAINING

a. All "emergency personnel" who could be exposed to ionizing radiation during the performance of their emergency response duties shall receive training on the following minimum topics:

- (1) Sources of radiation in areas where they may be required to respond.
- (2) Potential hazards associated with radiation sources in areas where they may be required to respond.
- (3) Relative priority of radiological controls versus other safety considerations during an emergency.
- (4) Procedures to avoid or reduce exposures in emergency response actions.
- (5) Procedures to avoid or reduce potential radioactive contamination in emergency response situations.
- (6) Personnel radiation safety requirements (i.e., protective clothing, stay times, dosimetry, etc.) for personnel entering radiation areas under emergency conditions.
- (7) Familiarization with the physical layout of facilities.
- (8) Persons to contact to provide radiological controls support during or after an emergency.

b. This initial training shall be of a minimum duration of two hours, shall be conducted by the RSO or a designated representative, and shall be documented.

2. PERIODIC TRAINING. Persons classified as "emergency personnel" shall receive annual training covering the scope of the initial training requirement. Additional training shall be provided whenever there is a significant increase in radiation exposure potential due to additional or different sources of ionizing radiation. Periodic training shall be conducted by the RSO or a designated representative and shall be documented.

2.2.9 RADIATION SAFETY TRAINING FOR OTHER ORGANIZATIONAL PERSONNEL

DISCUSSION:

Those personnel who work in or frequent areas adjacent to radiation areas or radioactive material storage areas, while not actually being involved in the RASP, may develop concerns about radiation because they often see radiation warning signs. To allay fears, it is incumbent upon the command to provide these personnel with a briefing.

REQUIREMENTS:

1. **INITIAL TRAINING.** Those personnel who routinely work in or frequent areas adjacent to radiation areas and radioactive material storage areas shall receive an initial briefing on the need to heed radiation warning signs and boundary markers.

These personnel shall be informed of the nature of potential radiation exposures and that the majority of their exposures come from natural background, man-made enhancements to background and medical exposures (with the latter comprising the most significant portion). The briefing should include an explanation of what is done to protect them from radiation exposure. All personnel should be encouraged to contact the RSO if they have additional questions regarding radiation exposure in their work areas.

2. **PERIODIC TRAINING.** Because of the sensitive nature of the subject of potential radiation exposures, the RSO shall repeat the initial briefing as frequently as necessary to allay concerns.

2.2.10 REQUIRED TRAINING RECORDS

DISCUSSION:

While the actual conduct of radiation safety training is vitally important to maintaining a sound radiation safety program and reducing personnel exposure to ALARA, it is also vital that this action be documented. Failure to document required training is considered to be evidence of failure to conduct required training and will be so noted in internal audits and compliance inspections.

REQUIREMENTS:

Radiation safety training records shall be maintained as follows:

1. **INITIAL RADIATION SAFETY TRAINING**

a. Records of initial radiation safety training for radiation workers are a permanent record and shall normally be retained in the individual's service record for military and official personnel folder for civilian employees.

b. For other categories of personnel, records of initial training shall be maintained in organizational training records for as long as the individual is assigned to the organization.

c. Records of initial training shall be course completion certificates or signed memorandums stating successful completion of specified initial training and copies of exams and scores of personnel. Memorandums of completion shall be signed by the RSO or individual conducting the training.

2. PERIODIC RADIATION SAFETY TRAINING

a. Records of required periodic radiation safety training for all categories of personnel shall be maintained by the RSO or activity training office for a period of three years.

b. Records of periodic training may be kept in any format. As a minimum, the record shall identify the date of training, subject matter covered, length of training, person(s) conducting the training, and attendees.

2.3 NAVY RADIOACTIVE MATERIALS PERMIT PROGRAM AND NUCLEAR REGULATORY COMMISSION LICENSED RADIOACTIVE MATERIAL

DISCUSSION:

Under the provisions of Title 10, Code of Federal Regulations (10 CFR), the Nuclear Regulatory Commission (NRC) has issued a Master Materials License to the Department of the Navy, to control the receipt, acquisition, possession, use and transfer of NRC licensed radioactive material. OPNAVINST 6470.3 established the Navy Radiation Safety Committee to implement the Navy Radioactive Materials Permit (NRMP) system and assigned responsibilities to control the use of NRC licensed radioactive material and naturally occurring and accelerator produced radioactive material (NARM). Tables 1 and 2 contain a partial list of NARM.

The NRC established general licenses in 10 CFR Parts 31, 40.22, 40.25 and 70.19 for items or products manufactured and distributed in accordance with a specific license issued by the NRC or an agreement state. General licensed items are normally identified in the manufacturer's instructions or on a caution label attached to the product. Commands can only transfer generally licensed items to a person holding an NRC or Agreement State license or a NRMP which authorizes receipt of the item.

10 CFR 30.11 through 30.19 identifies items that are exempt from requirements of 10 CFR 30 when the items are manufactured and distributed in accordance with a specific license issued by the NRC. Exempt items are identified by the letter E after the manufacturer's license number which is normally printed on a caution label on the device or in the manufacturer's instructions. 10 CFR 40.13 identifies source material

items which are exempt from licensing. Exempt items are still subject to the pertinent radiation control provisions in this manual.

NRMPs of broad scope (Type A, B and C) will generally be issued to naval commands qualifying for NRC license of broad scope as defined in 10 CFR 33.11.

2.3.1 NAVY RADIOACTIVE MATERIALS PERMITS (NRMPs)

REQUIREMENTS:

1. All Navy and Marine Corps commands that receive, possess, use, store, transfer or dispose of radioactive material which is not exempted by Section 2.3.2 shall obtain a NRMP.

2. Requests for initial issue, renewal, and amendments of NRMPs shall be:

a. Submitted to NAVSEADET RASO via the chain-of-command.

b. Submitted in duplicate, accompanied by the completed NRMP Application Form (Appendix B). NRC Form 313 shall be used until the NRMP Application Form is published.

c. Signed by the Commanding Officer or his designated representative.

d. Submitted to arrive at NAVSEADET RASO at least 90 days prior to expiration or desired approval date.

3. Each Navy and Marine Corps command receiving an approved NRMP shall comply with the conditions and requirements specified both in their approved application and the NRMP.

4. Each Navy and Marine Corps command requesting amendment of their NRMP shall continue to operate under the conditions of their current NRMP until the amendment is approved and an amended NRMP is received at the command.

5. Applications for renewal of NRMPs shall be complete without reference to previously submitted information.

6. Applications for renewal of a NRMP received by NAVSEADET RASO prior to the expiration date specified in the permit shall be considered to be timely filed if they meet the requirements of this part and pertinent 10 CFR sections. Notification of such "timely filed" status shall be provided by NAVSEADET RASO. The conditions of the existing permit shall remain in effect until final action is taken on the renewal request.

7. CNO may require NRMPs for item managers of some radioactive commodities that may otherwise be exempted under the provisions of Section 2.3.2.

8. NRMPs for certain supply items shall be issued to the Navy command responsible for inventory control and management of the item.

9. Sealed sources and devices, including military systems under contract development, shall be listed in the NRC Catalog of Approved Sealed Sources and Devices (registered) prior to issuance of a NRMP and receipt by a naval command, except as authorized by NRC policy directives.

10. Navy and Marine Corps commands holding NRC general licensed items shall obtain a NRMP when the command cannot comply with general license restrictions in 10 CFR 31.

11. Commands requesting or holding Type A permits of broad scope shall comply with requirements of 10 CFR 33.13.

12. Commands requesting or holding Type B permits of broad scope shall comply with requirements of 10 CFR 33.14.

13. Commands requesting or holding Type C permits of broad scope shall comply with requirements of 10 CFR 33.15.

2.3.2 EXEMPTIONS

REQUIREMENTS:

1. Except as CNO may direct, NRMPs are not required for radioactive material in quantities or concentrations less than the exempt concentrations or quantities specified in 10 CFR 30.71, Schedules A and B.

2. Except as CNO may direct, NRMPs are not required for radioactive material contained in a device or product distributed in accordance with the requirements of:

a. A specific NRC license for exempt distribution and 10 CFR 30.14 through 30.20.

b. A specific NRC or Agreement State license for general distribution and the requirements of 10 CFR 31.

3. Except as CNO may direct, NRMPs are not required for quantities of source material listed in 10 CFR 40.13 provided that all specified limitations and use requirements are met.

4. Except as CNO may direct, NRMPs are not required for quantities of naturally occurring or accelerator produced radioactive material less than quantities specified in Table 3.

2.3.3 TERMINATION OF ACTIVITIES AUTHORIZED BY A NRMP

REQUIREMENTS:

When a command decides to terminate all activities authorized by a NRMP, the command shall:

1. Transfer all radioactive material to a recipient authorized by a NRMP, NRC license, or Agreement State license to receive the radioactive material; or dispose of all radioactive material as radioactive waste.

2. Conduct a radiation survey to confirm the absence of radioactive material or to establish residual contamination levels. See paragraph 2.6.11.

3. Provide a written request to terminate the NRMP to NAVSEADET RASO to include:

a. A complete Navy Certificate of Disposition of Materials for Termination of Navy Radioactive Material Permit (Appendix C). NRC Form 314, Certificate of Disposition of Materials, shall be used until the Navy certificate is published.

b. A radiation survey report confirming the absence of radioactive material or to establish residual contamination levels. The radiation survey report shall comply with information requirements of 10 CFR 30.36(d)(v). If residual radioactive contamination above free release criteria is found:

(1) The NRMP shall continue in effect beyond the permit expiration date, if necessary, until remedial action is taken that permits free release of the facility for unrestricted use.

(2) The command shall make a reasonable effort to eliminate residual contamination.

(3) The command shall conduct decontamination operations under the supervision of the RSO or ARSO to prepare facilities and equipment for release to unrestricted use.

(4) Entry to restricted areas shall be controlled until written approval to release the area is received.

(5) Radioactive contamination shall be removed to the limits established in Table 4, unless a different limit is approved by the NRSC.

4. A NRMP is terminated only by written notice (termination amendment) from the NRSC.

2.3.4 UNAUTHORIZED POSSESSION OR USE OF RADIOACTIVE MATERIAL

DISCUSSION:

The following constitutes unauthorized possession or use of radioactive material:

1. Receipt or possession of radioactive material not authorized by a NRMP when required to obtain one under the requirements of Section 2.3.1.1 or specific direction of the NRSC.
2. Possession of quantities of radioactive material exceeding limits authorized in a NRMP.
3. Receipt or use of radioactive material in equipment, devices, or storage containers not approved for use by a NRMP (for example radiography equipment is approved for specific source model numbers, exposure devices, and source changers).
4. Use of radioactive material by an individual who is not qualified in accordance with conditions of a NRMP.

REQUIREMENTS:

When unauthorized possession or use of radioactive material is determined, the command shall:

1. Immediately withdraw the radioactive material or excess quantities from use and place in secure storage.
2. Transfer the radioactive material or excess quantities to a federal agency, company, or individual who holds a valid NRC or Agreement State license or to another naval command with a valid NRMP permitting the material as soon as possible.
3. Investigate the unauthorized possession of radioactive material, review procedures, and initiate necessary corrective action to prevent recurrence.
4. Report by letter to NAVSEADET RASO, within 30 days after the discovery of the unauthorized possession, describing circumstances and corrective actions taken.

2.4 REPORTING OF EQUIPMENT DEFECTS AND NONCOMPLIANCE FOR NRC LICENSED MATERIAL

DISCUSSION:

10 CFR Part 21 establishes procedures and requirements for reporting of defects and noncompliance with the Atomic Energy Act of 1954 as amended.

REQUIREMENTS:

1. Naval commands possessing and using NRC licensable materials authorized by a NRMP shall comply with the requirements of 10 CFR 21.
2. Each naval command shall establish procedures to:
 - a. Notify command designated officials of equipment defects and failure to comply (non-compliance) with 10 CFR, NRC orders or notices.
 - b. Evaluate equipment defects and failure to comply to determine if they could create a substantial safety hazard.
 - c. Maintain records of all evaluations. Records shall state a conclusion whether a substantial safety hazard could be created.
 - d. Take appropriate corrective action.
3. The following documents shall be conspicuously posted on any premises subject to 10 CFR 21.
 - a. Section 206 of the Energy Reorganization Act of 1974 which reads as follows:

"NONCOMPLIANCE

Sec. 206. (a) Any individual director, or responsible officer of a firm constructing, owning, operating, or supplying the components or any facility or activity which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended, or pursuant to this Act, who obtains information reasonably indicating that such facility or activity or basic components applied to such facility or activity —

(1) Fails to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the Commission relating to substantial safety hazards, or

(2) Contains a defect which could create a substantial safety hazard, as defined by regulations which the Commission shall promulgate, shall immediately notify the Commission of such failure to comply, or of such defect, unless such person has actual knowledge that the Commission has been adequately informed of such defect or failure to comply.

(b) Any person who knowingly and consciously fails to provide the notice required by subsection (a) of this section shall be subject to civil penalty in an amount equal to the amount provided by section 234 of the Atomic Energy Act of 1954, as amended.

(c) The requirements of this section shall be prominently posted on the premises of any facility licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended.

(d) The Commission is authorized to conduct such reasonable inspections and other enforcement activities as needed to ensure compliance with the provisions of this section.”

b. Either of the following:

(1) Procedures implementing 10 CFR 21 and copies of 10 CFR 21.

OR

(2) A notice which identifies a responsible individual by name to be notified and the location where procedures and regulations concerning 10 CFR 21 can be examined.

4. If a determination of a substantial safety hazard is made, an immediate OPREP-3 NAVY BLUE REPORT shall be made to CNO (OP-45) in accordance with OPNAVINST 3100.6. NAVSEASYS COM (SEAO6GN) and NAVSEADET RASO shall be information addressees to the OPREP report.

5. A written report shall be made within two days after submission of the initial OPREP-3 to CNO (OP-455), NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO and the chain of command. Report contents shall include information required by 10 CFR 21, Section 21.21(b)(3).

6. Command reporting requirements above shall be followed in lieu of any requirements in 10 CFR. Notification of the NRC is the responsibility of the NRSC (CNO-OP45).

2.5 REGISTRATION OF MACHINE SOURCES OF IONIZING RADIATION (RESERVED)

2.6 GENERAL RADIOLOGICAL CONTROLS PROCEDURES

DISCUSSION:

General radiation control procedures contained in this part are necessary for proper control of radioactive material and machine sources of ionizing radiation. Elements of general control include procurement and inventory of sources, administrative control to ensure occupational exposures are As Low As Reasonably Achievable (ALARA), control of areas, control of contamination and airborne radioactivity, protective clothing, receipt of packages, leak tests of sealed sources, decommissioning of facilities, recordkeeping, and radiation safety evaluations.

Radiation protection surveys and internal audits and inspections are the two categories of radiation controls program evaluations addressed in this Part. A radiation protection survey is a complete evaluation of a facility or operation. It includes a detailed review of procedures and equipment, as well as a complete radiation survey and documentation of radiation levels in all accessible areas. Internal audits and inspections are of variable scope and may include an evaluation of radiation levels at selected locations.

2.6.1 ADMINISTRATIVE CONTROL OF OCCUPATIONAL EXPOSURE

REQUIREMENTS:

1. At least annually, a formal review shall be conducted to identify operations with high exposures and recommend procedures for reduction of exposure.

2. All exposures above levels anticipated for the jobs and any exposure exceeding an authorized administrative control level shall be investigated and documented by the RSO.

2.6.2 PROCUREMENT, INVENTORY, AND NOTIFICATION OF PERSONS FOR RADIATION SOURCES

REQUIREMENTS:

1. Approval of the RSO is required prior to the procurement of radioactive material that contains radioactivity equal to or greater than the quantities listed in Table 3 or contains a specific activity greater than 0.002 microcuries per gram. Approval of the RSO is required prior to procurement of machines which produce ionizing radiation. Supply procedures shall be established to insure RSO approval of the procurement of any item containing radioactive material or any radiation producing machines.

2. The RSO shall maintain an inventory of all radioactive material authorized by NRMP, all radioactive commodities and all RASP machine sources of ionizing radiation.

a. For radioactive material, the inventory shall list a source identification number, radioisotope, chemical and physical form, activity, date of activity determination, location, and custodian.

b. For radiation producing machines, the inventory shall list machine description, model, serial number, maximum energy (kVp) and filament current (mA) or radiation output, location, and the custodian.

3. An inventory of radiation sources shall be conducted at least annually, unless otherwise specified in this manual.

4. Security and fire departments shall be provided:

a. A listing of permanent locations of radioactive material at least annually and when locations permanently change.

b. A listing of locations of radioactive material where radiation exposure, contamination, or airborne radioactivity may be produced as a result of fire.

c. Advance notification of locations of temporary high radiation areas not under direct supervision of an authorized individual (i.e., overnight calibration of high-range pocket dosimeters).

2.6.3 SHIPMENT, RECEIPT, AND OPENING OF PACKAGES

REQUIREMENTS:

1. Monitoring for external radiation and contamination on external surfaces of packages received or packaged for shipment shall be carried out near the receiving or packaging point.

2. Each command expecting receipt of a package containing radioactive material in excess of Type A quantities of radioactive material shall comply with requirements of

10 CFR 20.205(a) and (c) for notification, pickup, and monitoring of external radiation levels.

3. Each package labelled as containing radioactive material and not exempt as specified below shall be monitored by the RSO or his designated representative for removable external surface contamination within three hours if received during working hours or within 18 hours if received after normal working hours.

a. The following packages are exempt from surface contamination monitoring:

(1) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125.

(2) Packages containing only radioactive material as gases or in special form.

(3) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit.

(4) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

b. If removable radioactive contamination exceeds 0.01 microcuries per 100 square centimeters on the package surface, a report is required in accordance with paragraph 2.10.

4. Procedures shall be established for safely opening packages which are received. Consideration shall be given to the type of package being opened and the chemical and physical form of the contents.

2.6.4 LABELING, STORAGE, POSTING AND CONTROL OF AREAS

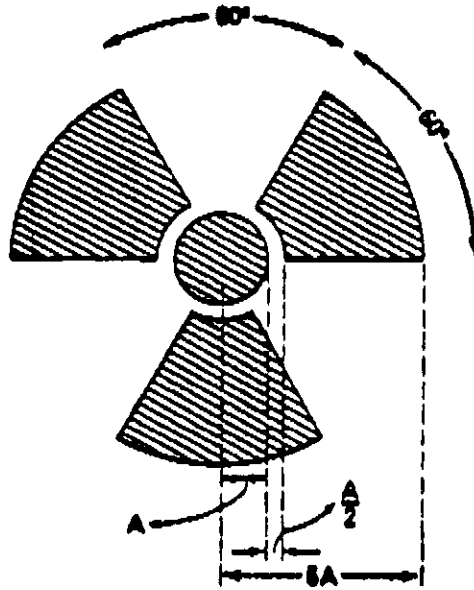
REQUIREMENTS:

1. Non-exempt quantities of radioactive material (greater than Table 3 quantities) shall be stored in a restricted area. Access shall be limited to the RSO and designated individuals. Radioactive material shall not be stored in office spaces, food storage areas, or berthing areas.

2. Non-exempt quantities of radioactive material in an unrestricted area shall be under the constant surveillance and immediate control of the RSO or a designated individual.

3. Each container containing greater than Table 3 exempt quantities of radioactive material shall be labeled in accordance with the requirements of 10 CFR 20.203(f).

4. Except as otherwise authorized by the NRSC or elsewhere in this manual, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on a yellow background). The symbol prescribed by this section is the conventional three bladed design:



RADIATION SYMBOL

Cross-hatched area is to be magenta or purple.
Background is to be yellow.

5. In addition to the contents of signs and labels prescribed in this section, information may be provided on or near such signs and labels which may be appropriate in aiding individuals to minimize exposure to radiation or radioactive material.

6. Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words: Caution – Radiation Area.

7. High radiation areas associated with the following specific operations, because of the significant radiation levels involved, shall be conspicuously posted with a sign or signs bearing the radiation trefoil symbol and the words: Danger – High Radiation Area.

- a. X-ray radiography.

b. Iridium -192 gamma radiography using a source equal to or greater than 100 curies, or cobalt-60 gamma radiography using a source equal to or greater than 35 curies.

8. High radiation areas, other than those identified in paragraph 7 above, shall be conspicuously posted with a sign or signs bearing the radiation trefoil symbol and the words: Caution – High Radiation Area.

9. Except as otherwise authorized by the NRSC or elsewhere in this manual, each entrance or access point to a high radiation area shall be:

a. Equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in one hour upon entry into the area; or

b. Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the licensee or a supervisor of the activity are made aware of the entry; or

c. Maintained locked except during periods when access to the area is required. Positive control shall be maintained over each individual entry.

10. The controls required by paragraph 9 above shall be established in such a way that no individual shall be prevented from leaving a high radiation area.

11. In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by paragraph 9 above.

12. Posting and control of restricted areas shall comply with the requirements of 10 CFR 20.203 and 10 CFR 20.204. Exceptions or alternative controls shall be approved by amendment of a NRMP prior to use.

13. Areas where radioactive contamination exceeds the limits of Table 4 shall be controlled as restricted areas and be posted with a sign which states "Caution – Radioactive Contamination Area".

14. Radiation levels in unrestricted areas shall comply with the requirements of Chapter 4, NAVMED P-5055.

15. NRMP permitted radioactive material in effluents to unrestricted areas shall comply with the requirements of 10 CFR 20.106.

16. Prior to disposal of radiation related signs and labels or uncontaminated containers bearing them, they shall be defaced and obliterated such that one may not misconstrue the uncontrolled presence of radiation or radioactive material.

2.6.5 RADIATION PROTECTION SURVEYS

REQUIREMENTS:

1. A radiation protection survey shall be conducted:
 - a. Before a new facility is put into routine operation. These records shall be maintained indefinitely.
 - b. After any significant changes in conditions from the initial radiation protection survey which could adversely affect radiation safety (facility modification, increase in operating parameters (energy, workload, occupancy, etc.)). These records shall be maintained indefinitely.
 - c. Every two years unless otherwise specified.
2. Required radiation protection surveys cited above shall be conducted by the RSO or ARSO (or an individual approved by NAVSEADET RASO) and a copy submitted to NAVSEADET RASO for evaluation and approval. Routine operation of facilities as described in paragraphs 1.a and 1.b shall not commence prior to approval of the survey by NAVSEADET RASO. Operations may continue after the survey described in paragraph 1.c if no unusual circumstances are noted.
3. Surveys and inspections shall be made as necessary to comply with specific requirements of this manual and to evaluate the extent of radiation hazards.
4. Safety devices in permanent facilities (lights, audible signals, warning signs, interlocks) shall be examined or inspected by personnel who are knowledgeable in their design, operation and maintenance at least every six months unless otherwise specified in this manual. Records of the results of semi-annual safety device examinations and inspections shall be maintained for three years.

2.6.6 CONTAMINATION CONTROL

GENERAL REQUIREMENTS:

1. Eating, drinking, chewing, or smoking shall not be allowed in contaminated areas or in areas where unsealed sources are used or stored.
2. Storage of food in contaminated areas shall not be allowed.
3. Eating, drinking, chewing or smoking while wearing potentially contaminated clothing shall not be allowed.
4. Pipetting radioactive liquids by mouth shall not be allowed.
5. Radioactive liquids and powders shall be carried in their containers and within another secondary nonbreakable container.

6. Separate sinks and drain systems shall be used in rooms or facilities where liquid radioactive material may leak, spill, or be disposed of.

7. Sinks, washbasins, traps, or floor drains used for disposal of radioactive liquids shall be marked with a label or sign including the radiation caution symbol and additional precautionary information.

8. A caution label shall be affixed to all containers actually containing, or contaminated with, radioactive material.

9. Chemical fume hoods, used to contain radioactive material in excess of Table 3 quantities, shall be equipped with a high efficiency particulate (HEPA) filter and shall be marked with a "Caution – Radioactive Material" sign or label.

10. The average velocity through the face of a chemical fume hood, used to contain radioactive material, shall be at least 100 linear feet per minute.

11. Protective clothing shall be removed or monitored for release before an individual leaves a contaminated area.

12. Individuals leaving a contaminated area shall be monitored for contamination using an AN/PDR-56 with small probe for alpha activity and an IM-247 APD or IM-249 series RADIAC with DT-304 probe for beta-gamma activity, as applicable. When a contact reading indicates detectable contamination, the affected area shall be decontaminated in accordance with NAVMEDCOMINST 6470.10 procedures.

13. Tools and equipment used in a contaminated area shall be routinely monitored and decontaminated as necessary before release to unrestricted areas.

14. Clothing and items released for unrestricted use shall meet the contamination limits in Table 4.

15. Any injury sustained in a contaminated area shall be reported to the RSO and evaluated by medical personnel.

16. Contamination control shall not take priority over medical treatment of injuries sustained in a contaminated area.

2.6.7 CONTROL OF AIRBORNE RADIOACTIVITY

REQUIREMENTS:

1. The ventilation systems associated with enclosures or areas having potential airborne radioactivity in excess of the quantities listed in Appendix B, Table II, 10 CFR 20 shall be carefully designed and operated to ensure that radioactivity releases to unrestricted areas are measured and controlled.

2. No individual in a restricted area shall be exposed to airborne radioactivity concentrations which exceed the limits in 10 CFR 20.103(a).

2.6.8 PROTECTIVE CLOTHING AND RESPIRATORY PROTECTION

REQUIREMENTS:

1. Protective gloves and clothing shall be worn by personnel who work with unsealed radioactive material in a readily dispersable form (liquid or powder), or who otherwise work in a radioactively contaminated area.

2. Respiratory protection equipment used pursuant to 10 CFR 20.103(a)(1) to limit the intake of radioactive material shall meet the requirements of 10 CFR 20.103(c).

2.6.9 LEAK TESTING OF SEALED RADIATION SOURCES

REQUIREMENTS:

1. Sealed sources containing more than 100 microcuries of beta-gamma emitting material or more than 10 microcuries of alpha emitting material shall be tested for leakage or contamination at intervals not to exceed six months except as specified below. Any source received by the command which is not accompanied by a certificate indicating that a test was performed within six months prior to the transfer shall not be put into use until tested.

a. Hydrogen-3, other gaseous form radioactive isotopes, and radioactive isotopes with half-lives less than 30 days are exempt from the periodic leak test requirement.

b. Leak test intervals exceeding six months are allowed if approved in a specific or general Nuclear Regulatory Commission license or NRMP.

c. Any source in storage and not being used is exempt from the periodic leak test requirement. When the source is removed from storage, it shall be leak tested prior to use or transfer.

2. Sources designed to emit alpha particles and containing more than 10 microcuries of alpha emitting material shall be tested for leakage and contamination at intervals not to exceed three months. Any source received by the command which is not accompanied by a certificate indicating that a test was performed within three months before the transfer shall not be put into use until tested.

3. The test sample shall be taken from the source or an adjacent surface where contamination is expected to accumulate.

NOTE:

Sources that emit alpha particles (i.e., plated and mylar covered alpha check sources) should be tested by wiping an adjacent surface and not the source directly.

4. The leak test shall be capable of measuring 0.005 microcuries of radioactivity.

5. If 0.005 microcuries or more of removable contamination is measured on the test sample, the actions below shall be accomplished:

a. The source shall be removed from service and decontaminated, repaired, or transferred for disposal. The source may be returned to the manufacturer when so stated on the label on the device or when incorporated into the specific license governing it.

b. A complete investigation of the source and extent of contamination shall be conducted.

c. Comply with the notification requirements of Section 2.10.

NOTE:

Different leak test limits may be approved in a NRMP for specific types of sources in accordance with NRC policy guidance.

6. Leak test records shall be maintained in units of microcuries or disintegrations per minute (dpm).

2.6.10 RECORDS AND REPORTS

REQUIREMENTS:

1. Radiation protection program records shall include the following:
 - a. Radiation protection surveys.
 - b. Radiation safety audits and inspections.
 - c. Radiation medical examinations (pre-placement, re-examination and termination as required in NAVMED P-5055).
 - d. All occupational radiation exposure and personnel dosimeter records, such as TLD. (NAVMED P-5055 applies.)
 - e. Medical records generated during the period of a radiation worker's employment (NAVMED P-5055 applies).
 - f. Radiation instrumentation maintenance and calibration records.
 - g. Pocket dosimeter logs.
 - h. Inspections of safety devices.
 - i. Sealed source leak test results.
 - j. Records of receipt, transfer, and inventory of radioactive material.
 - k. Utilization logs for radioactive sources.
 - l. Utilization logs of x-ray machines.
 - m. Training and qualification records of personnel using ionizing radiation sources.
 - n. Records and reports required by a NRMP.
 - o. Reports and records of overexposures, accidents, and significant incidents.
2. All medical records and personnel dosimetry records shall be maintained in accordance with NAVMED P-5055.
3. Records of surveys and disposal shall be maintained in accordance with 10 CFR 20.401.
4. As a minimum, survey records shall contain:

- a. Identification of the radiation source(s) and location.
- b. Dose rate levels and contamination levels, as applicable.
- c. Airborne radioactivity level (if applicable).
- d. Date and time of survey.
- e. Instrument(s) used by type and serial number.
- f. Calibration date of each instrument used.
- g. Name of surveyor.
- h. Date of review by and signature of RSO.

5. Inspections shall be documented so that radiological discrepancies and corrective actions taken are recorded, and a final review and statement of the adequacy of corrective actions taken are recorded. A final review and statement of the adequacy of corrective action shall be signed by the RSO and a more senior individual in the chain of command.

6. Records shall be retained:

- a. As specified in 10 CFR Parts 30.51, 40.61 and 70.51(b) for receipt, transfer, inventory and disposal of NRC licensed radioactive material.
- b. Indefinitely for surveys conducted to establish occupational exposure in the absence of personnel dosimetry.
- c. Indefinitely for surveys to decommission facilities for unrestricted use.
- d. For three years after termination of operations or until the next inspection by NAVSEADET RASO unless a longer period is specified in the NRMP or applicable section of 10 CFR.
- e. For at least three years if not otherwise specified in federal regulations, this manual or naval directives.

2.6.11 FACILITIES

REQUIREMENTS:

1. Navy and Marine Corps commands shall identify buildings, structures, storage areas or other facilities in which radioactive materials are located and establish records to reflect the location and nature of such materials. An exemption to this requirement exists when the only radioactive materials used within a facility are transient sealed

sources; sources not exceeding the exempt quantities or concentrations of 10 CFR 30.70; generally licensed or exempt sources under 10 CFR 31 which are not installed in the building either structurally or as a fixture; unsealed medical sources with short half-lives; or insignificant sources such as compasses, dials, gauges, electron tubes, or smoke detectors.

2. If these facilities need to be decommissioned or excessed, Navy and Marine Corps commands shall determine if the facility has been radiologically contaminated and, if necessary, conduct appropriate decontamination before decommissioning or excessing the facility (Section 2.6.13). Records of information important to the safe and effective decontamination of the facility shall be maintained and should include:

a. Records of spills or other unusual occurrences involving the spread of radioactivity in and around the facility. These records may be limited to instances when significant contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the possible seepage into porous materials such as concrete. These records must include any known information on identification of involved nuclides, quantities, forms, and concentrations.

b. As-built drawings and modifications of the facility including locations of possible inaccessible contamination such as buried pipes that may be subject to contamination. If drawings are not available, the Navy and Marine Corps command shall substitute appropriate records of available information concerning such facilities.

2.6.12 INTERNAL AUDITS AND INSPECTIONS

REQUIREMENTS:

1. The command RSO shall establish a formal internal audit and inspection plan that evaluates compliance with federal and Navy regulations, NRMP conditions, and the provisions of this manual.

2. Documented internal audits and inspections shall be conducted by the RSO or ARSO at least every six months unless otherwise specified in this manual, a NRMP or federal regulations.

3. The internal audit and inspection plan shall include, as a minimum, evaluation of the following applicable subject areas for operations involving RASP ionizing radiation sources. The audit and inspection frequency is every six months unless stated otherwise.

a. Radiation medical examinations (pre-placement, re-examination and termination as required in NAVMED P-5055).

b. Occupational radiation exposure and personnel dosimetry records and logs, e.g. TLD, and pocket dosimeter.

c. RASP related training – annually.

d. Radiological control procedures and practices – quarterly.

e. NRMP compliance – quarterly.

f. Receipt, transfer, and disposal of radioactive material.

g. Required records and reports.

h. Transportation – quarterly.

i. Corrective actions for discrepancies identified during previous audits or inspections.

4. Specific program inspection and audit procedures shall be developed by the command or activity to ensure compliance with Sections II through IX of this manual as appropriate.

5. All discrepancies found during an inspection or audit shall be tracked to completion, and a record maintained of corrective actions for a minimum of three years.

2.6.13 DECOMMISSIONING OF FACILITIES

REQUIREMENTS:

These requirements, in conjunction with Table 4, specify the radioactivity contamination limits and radiation exposure rate limits for decontamination and survey of facilities (excluding facilities exempted in paragraph 2.6.11) prior to abandonment or release for unrestricted use.

1. A reasonable effort shall be made to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a radiation protection survey, are below the limits specified in Table 4, prior to the application of the covering. A reasonable effort shall be made to minimize contamination prior to application of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other access points, when contamination at these locations is likely to be representative of contamination on the

interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be considered contaminated in excess of the limits.

4. Prior to release of facilities for unrestricted use, the command shall make a comprehensive radiation survey which establishes that contamination is below the limits specified in Table 4. A copy of the survey report shall be filed with NAVSEADET RASO at least 30 days prior to the planned date of release. The survey report shall:

- a. Identify the facilities and discuss the history of use.
- b. Show that a reasonable effort was made to eliminate residual contamination.
- c. Describe the scope of the survey and general procedures followed.
- d. Summarize the results of the survey in units specified in Table 4 and identify the surveyor and instruments used.

5. Release of the facilities is not authorized without written approval from NAVSEADET RASO.

2.7 SURPLUS RADIOACTIVE MATERIAL PROGRAM (RESERVED)

2.8 TRANSPORTATION OF RADIOACTIVE MATERIAL

DISCUSSION:

Regulations governing the transportation of hazardous material are designed to prevent undue exposures and injury to the general public during transport. For this reason, most regulations govern the design and construction of the transportation package or container.

The proper packaging, labeling and other tasks associated with the transportation of radioactive material are complex and dependent on the form, quantity and isotope of the radioactive material to be transported. It is not possible here to provide guidance to each activity for each potential transportation operation. Regulations concerning the transportation of radioactive material are provided in 49 CFR Parts 170–199 and 10 CFR Part 71. This section provides only general requirements.

A list of 49 CFR sections pertaining to radioactive material is presented in Table 5. It should be noted that Table 5 is a guide. Table 6 provides a brief description and selected quantity limits for package selection. Table 7 is used to determine exceptions to specification packaging.

REQUIREMENTS:

1. Prior to performing any transportation operation, each activity shall consult the appropriate section of this manual and the current edition of 49 CFR and 10 CFR 71.
2. Each command is responsible to insure personnel assigned duties to perform requirements of this part receive instructions regarding the applicable sections of 49 CFR Subchapter C (49 CFR 173.1(b)).
3. Any material having a specific activity equal to or less than 0.002 microcuries per gram is not considered to be radioactive material for the purposes of transportation. Specific activities are listed in 10 CFR 71, Appendix A.
4. Department of Transportation (DOT) regulations shall apply to the movement of radioactive material outside the boundaries of an activity.
5. No command shall offer any radioactive material for transport aboard a passenger-carrying aircraft unless the material is intended for use in medical treatment or diagnosis or research or exempted by 49 CFR 173.4 for limited quantities. Check sources and other similar sources may be transported on passenger aircraft under this exemption. No member of the aircraft flight crew is considered a passenger.
6. Transportation on military aircraft must comply with requirements of NAVSUPPUB 505.
7. The RSO is responsible for ensuring that all packages offered for transportation, or transported by the activity conform to all applicable requirements of this manual and 49 CFR.
8. The Supply Officer for each activity is responsible for ensuring that all radioactive material that has been properly packaged and certified is expeditiously transported to the receiving organization.
9. Prior to first use of any package, the shipper shall determine that the quality of design and construction meets the requirements of 49 CFR and 10 CFR 71.87, when applicable, and meets the specified limits in the package design by examination or written certification from the manufacturer or supplier of the packaging.
 - a. Special form documentation, to include supporting safety analysis or manufacturer's certification as specified in 49 CFR 173.476, shall be obtained and maintained for one year after shipment.
 - b. Written documentation of the tests and evaluations for Specification 7A packages shall be maintained for one year from last use of the package, to include the

original test report and any shipper comparison between limits of the package used and limits in the test report.

c. Written documentation for Type B packages shall include:

(1) Written certification from the package vendor or owner that the package was built and maintained in accordance with an NRC approved quality assurance program.

(2) Certificate of Compliance for NRC approved packages.

(3) Copies of applicable documents referenced in the certificate for use, maintenance, and actions required prior to shipment.

10. Prior to each shipment of radioactive material, the shipper shall determine that:

a. The package is proper for the contents to be shipped.

b. The package is in unimpaired physical condition.

c. External radiation and contamination levels are within limits.

d. Other special requirements of 49 CFR 173.475 and 10 CFR 71.87 (for shipment of more than Type A quantities) are met when applicable.

e. Records of the above determinations are maintained for at least three years after shipment.

11. Prior to shipment of greater than Type A quantities of radioactive material (which are defined as Type B), the shipper shall:

a. Obtain an NRC approved Quality Assurance Program. Applications shall be prepared in accordance with 10 CFR 71.101 and submitted to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington DC 20555 via NAVSEADET RASO.

b. Register as a user of any package approved by Certificate of Compliance prior to first use in accordance with 10 CFR 71.12(c)(3). Registrations shall be submitted via NAVSEADET RASO to Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

c. Comply with 10 CFR 71.5 and 49 CFR general requirements for packaging, marking, labelling, placarding, shipping papers and modes of shipment.

d. Comply with 10 CFR 71, Subpart G, Operating Controls, and Subpart H, Quality Assurance, requirements.

12. A record of each transfer of radioactive material shall be maintained for at least three years from the date the material is accepted by the carrier. As a minimum, the record shall contain the following:

- a. Verification that the receiving activity is licensed or authorized by a NRMP to receive the material.
- b. A copy of documentation identifying the radioactive material.
- c. For sealed sources, a copy of the current leak test certificate.
- d. A copy of the Bill of Lading or manifest for the shipment.
- e. A copy of the acknowledgement of receipt of the material.

2.9 RADIATION EMERGENCIES

DISCUSSION:

A radiation emergency can occur where radioactive materials or radiation-producing equipment are used, stored or transported. Depending upon the magnitude of events and the severity of consequences, the radiation emergency can be categorized as a radiological accident or incident.

Certain Navy directives and federal regulations require that cognizant authorities be notified within various time periods depending upon the magnitude of the emergency. This article specifies the various reporting procedures to be followed.

REQUIREMENTS:

1. The RSO shall prepare for the possibility of a radiation emergency by developing, testing and maintaining a radiation emergency response plan.

2. The following conditions, situations and occurrences shall be considered, as appropriate, in developing emergency plans:

- a. Real or suspected personnel overexposure.
- b. Personnel contamination.
- c. Unauthorized or accidental entry of personnel into a controlled area.
- d. Spills of radioactive material.
- e. Theft or loss of radioactive material or machines that produce ionizing radiation.
- f. Unplanned release of radioactive material into the environment.

- g. Receipt of packages with excessive contamination or radiation levels.
- h. Failure of safety devices to function properly such as interlock not terminating exposure.
- i. Failure of exposure device components to function properly such as gamma radiography source disconnect.
- j. Discharges or spills of material or fluids that might be considered pollutants which endanger critical water areas, have the potential to generate public concern, become the focus of enforcement action, or pose a threat to public health or welfare.
- k. Events involving radioactive material or radiation exposure which do not present a hazard to life, health or property, but which are of such a nature as to warrant immediate notification of cognizant higher commands. Included in this category are those events having domestic or international implications and those which are likely to give rise to inquiries by the public or press.
- l. Incineration of radioactive materials.
- m. Violation of operating procedures required by the NRMP.

3. Procedures shall identify conditions constituting an emergency, list by priority individual and departments to be notified (primary and alternates) during duty hours and off-duty hours, radiological exposure control, and actions to be taken to include responsibility for notifications required by Article 2.9.3.

4. Emergency plans for radioactive material shall be included in the NRMP application submitted to NAVSEADET RASO.

5. Emergency plans shall be reviewed and updated at least annually.

6. An exercise of the emergency plan shall be conducted at least annually under realistic conditions.

2.10 REPORTING OF RADIATION ACCIDENTS AND INCIDENTS

REQUIREMENTS:

1. The following situations involving NRMP controlled or accelerator-produced radioactive material shall require immediate voice or message notification using the

OPREP-3 NAVY BLUE procedures specified in OPNAVINST 3100.6C. COMNAVSEASYS COM (SEA-06GN) and NAVSEADET RASO shall be information addressees to OPREP-3 NAVY BLUE reports required under this section.

a. Radiation incidents defined in 10 CFR 20.403 that may have caused or threatens to cause:

- (1) Exposure of the whole body to five rems or more.
- (2) Exposure of the skin of the whole body to 30 rems or more.
- (3) Exposure of the feet, ankles, hands or forearms to 75 rems or more.
- (4) Loss of one day or more of the operation of any facilities affected.
- (5) Property damage exceeding \$2,000.

b. Receipt of a package (10 CFR 20.205) which has:

(1) Removable external surface radioactive contamination in excess of 0.01 microcuries (22,000 disintegrations per minute) per 100 square centimeters of package surface.

(2) Radiation levels in excess of 200 millirem per hour at the external surface or in excess of 10 millirem per hour at three feet from the external surface.

c. Loss or theft of radioactive material which may produce a substantial hazard to persons in unrestricted areas (10 CFR 20.402).

d. Loss (other than normal operating loss), theft, attempted theft of one gram or more or accidental criticality of special nuclear material (10 CFR 70.52).

e. Defects and failure to comply which could create a substantial safety hazard (10 CFR 21).

f. Leak test results of a sealed source indicating total removable activity exceeding 0.005 microcuries (10 CFR 31.5, 10 CFR 34.25 or NRMP conditions).

2. Overexposures and excessive levels and concentrations as defined in 10 CFR 20.405 shall be reported in writing to CNO (OP-45) within 15 days with a copy to NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO.

3. Exposures from ionizing radiation in excess of limits specified in NAVMED P-5055 shall be reported as specified in paragraph 5-3 of NAVMED P-5055.

NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO shall be information addressees to any report of overexposure.

4. Any exposure to an other-than occupationally exposed individual in excess of 500 mrem in a calendar year shall be reported in writing. Within 15 days, the written report shall be submitted to NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO which describes the details of the exposure and planned corrective steps to prevent a recurrence. Each report shall have a separate section which lists the name, address, telephone number, social security number, date of birth, and exposure estimate for each individual exposed.

5. In the event of a significant abnormal occurrence not covered by the notification requirements above, the command shall take appropriate measures to return the situation to normal. The command shall then notify NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO, review the matter, and document the review. Documentation of the review shall include preparation of a narrative summary which identifies the cause of the occurrence and specifies corrective action taken to prevent recurrence. A copy of the narrative summary concerning abnormal occurrences shall be sent to NAVSEADET RASO within 30 days after the occurrence of the incident or the discovery thereof. This requirement does not apply to x-ray and gamma radiography operations, both of which have separate reporting requirements specified in the pertinent sections of this manual.

2.11 FACILITY DESIGN AND SHIELDING REVIEW

DISCUSSION:

This part provides guidance and requirements for the design of new or modified facilities where ionizing radiation sources (materials or machines) will be used. Evaluation of planned operations and correct application of design standards and regulatory requirements will protect personnel while avoiding unnecessary expenditure of funds, and will eliminate the need for expensive modifications after construction. This part applies to Navy and Marine Corps facilities ashore and afloat using radiation sources for industrial purposes, including government owned-contractor operated (GOCO) and government owned-joint operated (GOJO) facilities. This part does not apply to sources such as analytical x-ray units, gas chromatographs, gauges, etc., where special construction is not required, or to medical and dental facilities. Review and approval of ionizing radiation safety features and shielding requirements for medical and dental facilities is the responsibility of BUMED.

REQUIREMENTS:

1. All facilities shall be designed and constructed so that the radiation levels in any accessible unrestricted area at one foot from the outside surface of the facility shall not

exceed two mrem in one hour. The radiation level in any normally occupied area around the facility shall be such that a person would not exceed 100 mrem in seven consecutive days or 500 mrem in one year. In addition, all facilities shall be designed and constructed to meet the applicable requirements of the following federal regulations:

- a. Title 10, Code of Federal Regulations, Part 20
 - b. Title 29, Code of Federal Regulations, Section 17, Part 1910.96
2. The design of facilities using sealed radioactive sources and radiation producing machines shall meet the applicable requirements of the following documents.
- a. NAVSEA S0420-AA-RAD-010, "Radiological Affairs Support Program" Manual.
 - b. National Bureau of Standards (NBS) Handbook 114, American National Standard N543-1974, "General Safety Standard for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV", 1975.
 - c. National Council on Radiation Protection and Measurements (NCRP) Report No. 38, "Protection Against Neutron Radiation", 1971.
 - d. National Council on Radiation Protection and Measurements (NCRP) Report No. 51, "Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerators", 1977.
 - e. National Council on Radiation Protection and Measurements (NCRP) Report No. 88, "Radiation Alarms and Access Control Systems", 1987.
 - f. National Bureau of Standards (NBS) Handbook 107, American National Standard N43.1-1978, "Radiological Safety in the Design and Operation of Particle Accelerators", 1979.
3. Facilities for use of unsealed radioactive material shall meet the applicable requirements of National Bureau of Standards (NBS) Handbook 92, "Safe Handling of Radioactive Materials", 1964.
4. Commands planning to build or modify facilities for the use of radiation sources shall submit a design plan to NAVSEADET RASO at the 35 percent and 100 percent design review or equivalent stage (prior to construction) for review and approval. Commercial prefabricated x-ray vaults which meet the requirements of a cabinet x-ray system specified in 21 CFR 1020.40 do not require a review of design plans. Commands which procure a prefabricated x-ray vault shall obtain certification from the manufacturer that the vault meets the requirements of 21 CFR 1020.40 for the machines to be used in the vault.

5. The following information shall be submitted with the design plan to NAVSEADET RASO:

a. X-Ray Sources (Industrial Radiography Only)

- (1) X-ray machine make and model number.
- (2) Maximum kVp and mA.
- (3) Phase of the x-ray system (single-phase or three-phase).
- (4) Maximum rated radiation output (R per minute at one meter from focal spot at maximum kVp and mA) for continuous operation.
- (5) Manufacturer's specified x-ray tube head leakage (R per hour at one meter).
- (6) Future plans for use of a larger machine.
- (7) Maximum x-ray exposure time for longest technique (minutes).
- (8) kVp, mA and time of technique requiring the greatest operating parameters.
- (9) Maximum number of x-ray exposures in any one hour.
- (10) Maximum number of x-ray exposures in any seven consecutive days.
- (11) Minimum x-ray tube focal spot-to-film distance (FFD) (inches or meters).
- (12) Administrative controls or mechanical restrictions placed on the x-ray tube to prevent aiming the primary x-ray beam at any particular barrier. Identification of barrier(s) which will not be struck by the direct x-ray beam.
- (13) Explanation of the use and occupancy of all facilities and rooms around, above, and below the room containing the ionizing radiation source.

b. Gamma-Ray Sources (Industrial Radiography)

- (1) Isotope, manufacturer and model number.
- (2) Maximum source activity, in curies.
- (3) Manufacturer's specified storage container or device external radiation level at a specified distance.

(4) Manufacturer's specified collimator leakage (R per hour at specified distance, or specified percent of primary beam exposure rate).

(5) Collimator aperture size.

(6) Maximum source exposure time for longest exposure technique (minutes).

(7) Maximum number of source exposures in any one hour.

(8) Maximum number of source exposures in any seven consecutive days.

(9) Minimum source-film distance (SFD) (inches or meters).

(10) Use or non-use of a collimator with the source(s) and exposure device. If used, cite administrative controls or mechanical restrictions placed on the collimator to prevent aiming the direct gamma ray beam at any wall, floor, or ceiling. If used, cite which barrier(s) will not be struck by the direct gamma ray beam.

(11) Explanation of the use and occupancy of all facilities and rooms around, above and below the room containing the ionizing radiation source.

c. Neutron Sources

(1) Isotope, manufacturer and model number.

(2) Neutron flux (neutrons/second) or neutron fluence (neutrons/cm² – second).

(3) Radiation level (mrem/hour) or fluence external to the device during storage.

d. All Sources

(1) Type and thickness of construction materials in the walls, floor and ceiling.

(2) Dimensions of the room in which the source is to be used. Include floor size, height of ceiling or roof, distance to floor of lower level, etc.

(3) Location of radiation source within shielded facility (i.e., distance from walls, floor, ceiling and targets).

(4) Presence of other nearby radiation sources which contribute to radiation levels outside the facility.

(5) Location and function of safety system items such as interlocks, warning lights and alarms, and access controls to radiation and high radiation areas.

(6) Detailed plans of any penetrations through walls, ceiling, floor or doors of radiography room.

(7) Plans or statements which show or describe installation details and shielding materials. This should include: joints between sheets and panels, joints at bends (i.e., corners), door jambs, lintel, thresholds (astragal), door latches and knobs, shield penetrations, and how the shielding material will be secured.

2.12 EXTERNAL AUDITS AND INSPECTIONS

2.12.1 NOTICE OF RASP INSPECTIONS

DISCUSSION:

As required by OPNAVINST 6470.3 and NAVSEAINST 5100.18A, NAVSEADET RASO audits and inspects all RASP radiation safety programs to determine compliance with federal and Navy regulations, the provisions of this manual, and the requirements of any applicable Navy Radioactive Materials Permit (NRMP). The RASP audit and inspection program includes personnel training, facilities, operations, and equipment.

An inspection may be announced or unannounced. Inspection frequencies are established (see Table 8) based on NRC license requirements, the type(s) of operation(s), and inspection history. Commands will normally be notified at least 90 days prior to an announced inspection.

During inspections, the radiation health program is normally included in the review. Copies of radiation health program deficiencies will be forwarded to BUMED (MED-21) for information and action.

It should be noted that under the conditions of the NRC Master Materials License issued to the Navy, the NRC reserved the right to conduct inspections of the Navy program, including individual permittees, at times and places the NRC considers appropriate.

REQUIREMENTS:

1. The command to be inspected is responsible for coordination of announced inspections. Written acknowledgement and the name and telephone number of a designated command representative shall be provided to NAVSEADET RASO upon receipt of inspection notification. Inspection coordination includes scheduling a pre-inspection briefing with the Commanding Officer, Officer in Charge, or his designated representative, access authorizations or badges. The command shall insure that local radiation health personnel are informed.

2. During the inbriefing, the inspector shall be provided a detailed listing, to include building numbers or site location, of all RASP operations (this includes operations not included in the current inspection), an accurate inventory of RASP ionizing radiation sources, and, where applicable, the license or NRMP number which authorizes the operation.

3. The command shall make available to the inspector any records, logs or other documents necessary to demonstrate compliance with federal and Navy regulations, this manual, and the NRMP, and shall be prepared to demonstrate the safe use of ionizing radiation in all areas of operation.

4. The command RASP RSO or ARSO shall accompany the inspector throughout the inspection. If the RSO or ARSO cannot be available, a knowledgeable replacement shall be designated.

5. When hosting inspectors from the NRC, Navy commands authorized to use radioactive materials under the authority of a NRMP shall cooperate fully with NRC compliance inspectors to include making available any records, logs or other documents necessary to demonstrate compliance with federal regulations and NRMP conditions.

2.12.2 INSPECTION PROTOCOL AND REPORTS

DISCUSSION:

The RASP system for rating the command's overall radiation safety program consists of two categories, satisfactory and unsatisfactory. Satisfactory ratings will be given to those commands where no significant radiation safety program violations are found. A rating of unsatisfactory will be given when there is an actual or substantial risk of the loss of safety or security as a result of methods or operations. Loss of safety is considered to have occurred if conditions exist where personnel overexposure could realistically occur. Loss of security is considered to have occurred if licensed radioactive material is not maintained according to the requirements of this manual, the appropriate sections of Title 10, Code of Federal Regulations, or the provisions of the applicable NRMP. In general, a loss of security occurs when non-exempt quantities of radioactive materials are not secured or under the positive control of authorized personnel.

To meet the requirements of the Navy Master Materials License and OPNAVINST 6470.3, a severity level system has been developed consistent with the NRC system described in 10 CFR 2, Appendix C, Supplement IV. Severity levels will be escalated if circumstances surrounding the matter involve careless disregard of requirements, deception, willful violation or material false statements. Willfulness embraces a

spectrum of violations ranging from deliberate intent to violate or falsify to, and including, disregard for requirements. Willfulness does not include single acts that do not rise to the level of careless disregard (i.e., inadvertent clerical errors are not considered willfulness). Willfulness can include repeat violations of an operational nature.

As required by OPNAVINST 6470.3, the Deputy Chief of Naval Operations (Logistics) is advised of all Severity Level I, II or III items of non-compliance as they apply to material controlled by a NRMP.

SEVERITY LEVELS:

1. SEVERITY LEVEL I reflects an actual loss of safety or security. A command will receive an unsatisfactory evaluation for any Severity Level I violation. Examples are:

a. Single exposure of a worker in excess of 25 rem of radiation to the whole body, 150 rem to the skin of the whole body, or 375 rem to the feet, ankles, hands or forearms.

b. Annual whole body exposure of a nonoccupational radiation worker or member of the general public in excess of 2.5 rem.

c. Release of radioactive material to an unrestricted area in excess of ten times the limits in 10 CFR 20.106.

d. Improper disposal of licensed material in quantities or concentrations in excess of 10 CFR 20.303 limits.

e. Exposure of a worker in a restricted area in excess of ten times the limits specified in 10 CFR 20.103.

2. SEVERITY LEVEL II violations are also the result of the loss of safety or security. Generally, a command will receive an unsatisfactory evaluation for a Severity Level II violation when mitigating circumstances are absent. Examples are:

a. A single exposure of a radiation worker in excess of:

(1) Five rem whole body.

(2) Thirty rem to the skin of the whole body.

(3) Seventy-five rem to the feet, ankles, hands, or forearms.

b. Annual whole body exposure to a nonoccupational radiation worker or member of the general public in excess of 0.5 rem.

c. Release of radioactive material to an unrestricted area in excess of five times 10 CFR 20.106 limits.

d. Failure to make the immediate notification required by 10 CFR 20.403(a) paragraphs (1) and (2).

e. Improper disposal of licensed material in quantities and concentrations in excess of five times 10 CFR 20.303 limits.

f. Exposure of a radiation worker in a restricted area in excess of five times 10 CFR 20.103 limits.

3. SEVERITY LEVEL III violations exist when there is a realistic potential for the loss of safety or security. An unsatisfactory rating is considered for Severity Level III violations. Examples are:

a. A single exposure of a radiation worker in excess of:

(1) Three rem to the whole body.

(2) 7.5 rem to the skin of the whole body.

(3) 18.75 rem to the feet, ankles, hands or forearms.

b. A radiation level in an unrestricted area such that an individual could receive greater than 100 mrem in any one hour period or 500 mrem in any seven consecutive days.

c. Failure to make the 24 hour notification required by 10 CFR 20.403(b) or immediate notification required by 10 CFR 20.402(a).

d. Substantial potential for an exposure or release in excess of 10 CFR 20 limits whether or not the exposure or release occurs (e.g., entry into high radiation areas, without having performed an adequate survey, or operation of a radiation facility with a nonfunctioning interlock system).

e. Release of radioactive material to unrestricted areas in excess of 10 CFR 20.106 limits.

f. Improper disposal of licensed material not covered in severity levels I and II.

g. Exposure of a worker in restricted areas in excess of 10 CFR 20.103 limits.

h. Release for unrestricted use of contaminated or radioactive material or equipment that poses a realistic potential for significant exposure to non-radiation workers or members of the public or that reflects programmatic (rather than isolated) weakness in the radiation control program.

i. Cumulative radiation worker exposure above regulatory limits when such cumulative exposure reflects programmatic rather than an isolated weakness in radiation protection.

j. Conduct of permittee activities by a technically unqualified person.

k. Significant failure to control licensed material.

4. SEVERITY LEVEL IV violations are those that have more than minor safety or environmental significance. An unsatisfactory rating may be considered for Severity Level IV violations similar to previous violations which the command did not attempt to correct. Normally similar violations that occur after the date of the last inspection or two years, whichever period is greater, are considered in evaluating Severity Level IV violations for program rating. Examples are:

a. Exposure in excess of the limits of 10 CFR 20.101 not constituting severity level I, II, or III violations.

b. A radiation level in an unrestricted area such that an individual could receive greater than two millirem in any one hour period or 100 millirem in any seven consecutive days.

c. Failure to make a 30 day notification required by 10 CFR 20.405.

d. Failure to make a follow-up written report required by 10 CFR 20.402(b), 20.408, and 20.409.

5. SEVERITY LEVEL V violations have minor safety and environmental significance. Severity Level V violations will not necessitate a program evaluation of unsatisfactory.

REQUIREMENTS:

1. During the inspection, the NAVSEADET RASO inspectors shall use checklists.

2. At the conclusion of the inspection, the Commanding Officer, Officer in Charge, or designated representative, shall be presented a copy of the checklist, which includes preliminary findings, severity levels, and preliminary overall radiation safety program rating of satisfactory or unsatisfactory.

3. Formal written inspection reports shall be routed via the appropriate chain of command with an advance copy to the inspected activity.

4. The command shall respond to adverse findings in writing as instructed in the inspection report. Written responses shall be made within 60 days, and subsequent reports at 30 day intervals until all negative findings and discrepancies are corrected.

5. Unsatisfactory radiation safety programs shall be evaluated for potential operation stoppage by the appropriate headquarters. All unsatisfactory programs shall be re-inspected within six months.

2.13 CONTRACTOR USE OF NRC LICENSED RADIOACTIVE MATERIAL OR MACHINE SOURCES OF IONIZING RADIATION ON NAVY PROPERTY

REQUIREMENTS:

1. Prior to operation of prototype or developmental systems using radioactive material or machine sources of ionizing radiation on Navy property, naval commands shall provide a copy of operating procedures and complete information, including, when applicable, copies of contractor NRC or Agreement State licenses regarding system process and operation, to NAVSEADET RASO for review. NAVSEADET RASO shall apprise the command of any radiation safety shortcomings to be rectified prior to commencing operations. Navy personnel shall not be used as operators under a NRC or Agreement State license issued to a contractor.

2. Naval commands engaged in negotiating contracts shall include in the terms of the contract a clause requiring compliance with Navy regulations and the requirements of this manual. When applicable, contractors shall be required to provide a copy of a NRC or Agreement State License or certificate of registration. For Agreement State Licenses, the contractor shall be required to provide written notification to the NRC Regional Office required by 10 CFR 150.20.

SECTION III

GAMMA RADIOGRAPHY

3.1 INDUSTRIAL GAMMA RADIOGRAPHY PROGRAMS

DISCUSSION:

Industrial gamma radiography creates a significant potential for unnecessary exposure or overexposure to ionizing radiation to radiography personnel and members of the general public in the vicinity of radiography operations. Because of this potential for personal injury and the fact that gamma radiographers have one of the poorest radiation safety records of any industrial radiation workers, the Nuclear Regulatory Commission (NRC) has established strict, comprehensive regulations for gamma radiography operations, and storage and handling of the gamma radiography sources. These rules are contained in 10 CFR 34 and are incorporated into every Navy Radioactive Materials Permit (NRMP) for gamma radiography.

REQUIREMENTS:

1. No Navy or Marine Corps activity shall conduct gamma radiography or obtain gamma radiography equipment prior to obtaining a valid NRMP authorizing possession of such equipment and conduct of specific operations.
2. All Navy or Marine Corps activities authorized by a NRMP to conduct gamma radiography shall operate their program in strict compliance with federal regulations, 10 CFR, the requirements of this manual, and requirements of their NRMP.
3. Each command authorized to conduct gamma radiography operations by a NRMP shall appoint a Radiation Safety Officer (RSO) and an Assistant Radiation Safety Officer (ARSO). The ARSO shall be capable of acting in all capacities in the absence of the RSO.

3.2 NRC REQUIREMENTS FOR CONDUCTING GAMMA RADIOGRAPHY

DISCUSSION :

NRC regulations are published in 10 CFR. Copies may be purchased from: Superintendent of Documents, Government Printing Office, Washington, DC 20402 (telephone 202-783-3238).

REQUIREMENTS:

1. Navy and Marine Corps activities authorized by a NRMP to conduct gamma radiography shall comply with the following:

10 CFR 19	Notices, Instructions and Reports to Workers; Inspections
10 CFR 20	Standards for Protection Against Radiation
10 CFR 21	Reporting of Defects and Noncompliance
10 CFR 30	Rules of General Applicability to Domestic Licensing of Byproduct Material
10 CFR 34	Licenses for Radiography and Radiation Safety Requirements for Radiographic Operators
10 CFR 71	Packaging and Transfer of Radioactive Material

2. Navy and Marine Corps activities authorized by a NRMP to conduct gamma radiography shall maintain a current copy of the above listed parts of 10 CFR.

3.3 NAVY REQUIREMENTS FOR GAMMA RADIOGRAPHY

DISCUSSION:

Navy requirements are in addition to the federal requirements of 10 CFR. They are intended to amplify NRC requirements or to meet a specific need of the Navy. The Navy requirements are equally or more restrictive than those of the NRC.

REQUIREMENTS:

1. In the unlikely event that federal and Navy requirements are in conflict, the more restrictive requirement shall take precedence and is considered inclusive of the lesser requirement. NAVSEADET RASO shall be notified by telephone and in writing of the exact nature of the conflict and shall provide a resolution expeditiously.

2. All Navy and Marine Corps activities authorized to conduct gamma radiography shall conduct operations in strict compliance with their NRMP.

3. In addition to the posting requirements of 10 CFR 20.203 and 20.204, all entrances to permanent gamma radiographic installations shall be posted with a sign

containing the conventional magenta or purple three-bladed radiation symbol and the words "Caution – Entering Radiation Exposure Room" on a yellow background.

3.3.1 TRAINING AND EXPERIENCE – FLEET COMMANDS

REQUIREMENTS:

1. Each RSO and ARSO, regardless of prior training and experience, shall have successfully completed the Radiation Safety Officer Course (S-4J-0016) or its historical equivalent A-4J-0016 conducted by NAVSEADET RASO.

2. Each Navy tender or Shore Intermediate Maintenance Activity (SIMA) RSO and ARSO shall have successfully completed the Radiographic Safety Training Course (S-4J-0020) conducted by NAVSEADET RASO or the historical equivalent (A-4J-0017) conducted by Service Schools Command, San Diego, California. Exceptions to paragraph 1 above and this paragraph will be considered on a case-by-case basis. Requests for exceptions shall be in writing and addressed to NAVSEADET RASO. Sufficient details shall be provided to permit a thorough evaluation of the concerned individual's training and experience.

3. In the event the RSO is not a qualified gamma radiographer with one year experience, the ARSO shall be the Senior Radiographer at the command and shall have a minimum of one year actual experience as a qualified gamma radiographer. In such cases, the ARSO shall have primary responsibility for all physical manipulations of the source such as:

- a. Source exchange.
- b. Leak testing.
- c. Recovery of damaged, disconnected or lost sources.
- d. Other equipment malfunctions.
- e. Maintenance of exposure devices.

4. The responsibilities in paragraph 3.3.1.3 above shall be clearly outlined in the NRMP application.

5. Radiographers and radiographers' assistants shall be trained in accordance with the provisions of this manual, 10 CFR and individual NRMPs.

6. At least one simulated accident drill shall be conducted annually as a part of annual refresher training.

7. Radiation barrier monitors shall be trained in accordance with the requirements of Section II, Part 2 of this manual.

3.3.2 TRAINING AND EXPERIENCE – SHORE COMMANDS

1. Each RSO and ARSO shall complete the Radiation Safety Officer Course (S-4J-0016) or its historical equivalent (A-4J-0016) conducted by NAVSEADET RASO. Other equivalent training and experience will be evaluated by the NRSC on a case-by-case basis (See paragraph 2.2.1).

2. In the event neither the RSO nor the ARSO is a qualified gamma radiographer with at least one year experience, the command shall designate in its NRMP application, a person who is a qualified gamma radiographer with at least one year experience, as the person responsible for the day-to-day supervision of the gamma radiography program.

3. In all instances the person with primary responsibility for daily supervision of the gamma radiography program and for all physical manipulations of the source such as those listed below shall be a qualified gamma radiographer with at least one year experience.

- a. Source exchange.
- b. Leak testing.
- c. Recovery of damaged, disconnected or lost sources.
- d. Other equipment malfunctions.
- e. Maintenance of exposure devices.

4. The responsibilities in paragraph 3.3.2.3 above shall be clearly outlined in the NRMP application.

5. Radiographers and radiographers' assistants shall be trained in accordance with the provisions of this manual, 10 CFR and individual NRMPs.

6. At least one simulated accident drill shall be conducted annually or as a part of annual refresher training.

7. Radiation barrier monitors shall be trained in accordance with the requirements of Section II, Part 2 of this manual.

3.3.3 DOSIMETRY

REQUIREMENTS:

1. All personnel participating in gamma radiography operations (including barrier monitors) shall wear two low-range self-indicating pocket dosimeters and an approved primary dosimetric device as specified in NAVMED P-5055. In the event of

documented shortages beyond the control of the using command, the RSO may grant written authorization to temporarily use one pocket dosimeter per person.

2. All radiographers and radiographers' assistants (excluding barrier monitors), conducting gamma radiography operations outside of a permanent radiographic installation or in a permanent radiographic installation not equipped with warning alarms required by 10 CFR 34.29, shall wear an alarming ratemeter in addition to the dosimeter specified in paragraph 1 above (10 CFR 34.33(a)).

3. Only those alarming ratemeters provided by the Navy RADIAC Program are acceptable to meet this requirement. Each alarming ratemeter shall be calibrated at periods not to exceed one year, and shall be checked to ensure that the alarm functions properly (sounds) prior to use at the start of each shift (10 CFR 34.33(f)).

4. Pocket dosimeters shall be checked at periods not to exceed six months for correct response to radiation. Acceptable dosimeters shall read within plus or minus 30 percent of the true radiation exposure. Records of pocket dosimeter radiation response checks shall be kept at the activity for six months from the last expiration date. Verification sheets provided by the servicing RADIAC calibration facility will suffice for this record.

5. Pocket dosimeters shall be the IM-235, IM-9 or commercial equivalent. The commercial equivalent shall have a range of 0-200 mR.

6. When conducting gamma radiography in reactor compartments under the control of the Navy Nuclear Propulsion Program, the primary dosimetric device shall be the same as that used by that program.

7. Pocket dosimeters shall be worn adjacent to the individual's primary dosimetric device.

8. Pocket dosimeters shall be zeroed at the start of each shift during which personnel will actually conduct gamma radiography. Absolute zero need not be attained. However, the pocket dosimeter should be adjusted to read less than 10 mR. If it cannot be brought to read less than 10 mR, attempt to rezero it on another charger. If it still does not read less than 10 mR, it shall be rejected and returned to a calibration facility for evaluation.

9. Pocket dosimeters shall be read often during the shift. The initial, final and net readings for pocket dosimeters shall be recorded in a pocket dosimeter log.

10. Pocket dosimeters found to be off-scale during radiography operations require immediate action to evaluate and minimize possible personnel exposure.

11. If only one pocket dosimeter goes off-scale, the individual shall immediately be removed from radiation work. The primary dosimetric device shall be immediately returned to the Naval Dosimetry Center for evaluation. The Dosimetry Center shall be contacted by telephone or naval message to ensure proper routing is achieved. The individual may be allowed to return to work before the results of the primary dosimetric evaluation are known if ALL of the following conditions are met:

a. The RSO can clearly establish that the off-scale pocket dosimeter is defective (See paragraph 10 below).

AND

b. The pocket dosimeter which was not off-scale is functioning properly (see paragraph 10 below) and reads less than 10 mR.

AND

c. The RSO has determined that the individual was not exposed beyond the permissible limits in NAVMED P-5055 or established administrative limits.

12. In the event one pocket dosimeter goes off-scale, the following checks shall be performed on both pocket dosimeters (NOTE: Facilities with a RADIAC Calibration Laboratory shall perform a calibration check using NAVSEASYS COM (SEA-04R) procedures):

a. Drift Check. Charge to zero, then observe after two hours. Within the context of this procedure, a defective pocket dosimeter is one that undergoes greater than one-fourth of full scale deflection (upward drift) within two hours.

b. Response Check. If the pocket dosimeter passes the drift check then a response check shall be performed as follows:

(1) Ensure that the pocket dosimeter has a current calibration sticker attached (NOTE: Re-calibrations are required every six months).

(2) Zero the pocket dosimeter to be checked.

(3) Tape the side of the sensitive end of the pocket dosimeter to a cesium-137 check source such as those used for the radiography survey meters.

(4) After two hours, read the pocket dosimeter.

(5) Any upscale reading indicates a positive response and the dosimeter is considered good.

(6) If no upscale reading is noted, the pocket dosimeter shall be considered defective.

13. If both pocket dosimeters go off-scale or if only one goes off-scale and the other indicates a radiation exposure of greater than 10 mR, the individual shall not be permitted to return to radiation work until the results of the primary dosimetric device evaluation are known.

3.3.4 RADIATION SURVEYS

REQUIREMENTS:

1. GENERAL

a. Radiation surveys shall be conducted with RASP approved survey instruments which are capable of measuring 2 mR/hour to 1,000 mR/hour.

b. RASP approved survey instruments supporting gamma radiography shall be calibrated at least every three months and after each repair or servicing at the nearest Navy RADIAC Calibration Laboratory or RADIAC Repair Facility.

c. Uncalibrated survey instruments, or those whose last calibration date exceeds three months, shall be removed from service and shall not be used.

d. Records of the calibration of radiation survey instruments shall be retained at the activity for three years after the last expiration date.

e. Survey instruments shall be checked for condition of batteries and acceptable response to radiation using the accompanying check source (when provided) prior to the first operation of the day or shift and after suspected damage (e.g., dropping).

f. Survey instruments without a provided check source shall be checked by surveying a specific point on the exposure device prior to removal of the exposure device from storage. Compare the instrument reading with the last reading recorded in the utilization log.

g. Inoperable survey instruments shall be removed from service and turned in for repair. If prompt turn in is not possible, they should be tagged to indicate the condition of the instrument. (NOTE: Inoperable includes poor battery condition (if they cannot readily be replaced) or failure to respond to radiation properly.)

h. Radiography operations shall not be conducted unless two operable, calibrated, low-range survey instruments are available.

i. Radiation surveys of exposure devices and source changers shall be made by a qualified radiographer.

j. Radiation surveys of restricted area perimeters shall be conducted by radiation barrier monitors or radiographers.

2. MANDATORY RADIATION SURVEYS

The following survey requirements are specific to gamma radiography and are in addition to requirements contained in other chapters of this manual.

a. The exposure device shall be surveyed prior to removal from storage, prior to transport and prior to placement in storage.

b. The entire circumference of the radiographic exposure device and the attached source guide tube (if one is used) shall be surveyed after each exposure to verify that the sealed source has been returned to the shielded position.

c. During the first exposure, for operations outside of a permanent radiographic facility, the restricted area perimeter shall be surveyed and adjusted as required to ensure that personnel in all accessible unrestricted areas would receive less than two mrem in any one hour or 100 mrem in any seven consecutive days.

d. The restricted area perimeter shall be resurveyed if substantial changes occur which could adversely affect radiation levels at the restricted area perimeter.

3.3.5 INTERNAL RADIATION SAFETY INSPECTIONS

DISCUSSION:

The requirements of this part are in addition to the internal audit and inspection requirements in Section 2.6.12.

REQUIREMENTS :

1. The internal radiation safety inspection program for gamma radiography shall include an observation every three months of the on-the-job performance of each radiographer and radiographers' assistant during an actual radiographic operation. Operations shall not be scheduled solely to fulfill this requirement.

2. If a radiographer or radiographers' assistant has not participated in a radiographic operation for more than three months since the last inspection, that individual's performance shall be observed and recorded the next time the individual participates in a radiographic operation.

3. Local internal inspection checklists shall be developed and shall include, as a minimum, evaluation of the following:

- a. Proper use of dosimetric devices.
- b. Control and posting of areas.
- c. Use of radiation survey instruments.
- d. Completion of records and logs.
- e. Knowledge of, and compliance with, command operating and emergency procedures.

4. Records of internal radiation inspection shall be retained for a minimum of three years.

5. Whenever possible, internal inspections shall be unannounced.

6. Internal radiation safety inspections, which include evaluation of the performance of radiographers or radiographers' assistants, shall be performed only by the RSOs or other designated individuals with a minimum of one year of actual experience as a radiographer.

3.3.6 OPERATIONS OUTSIDE OF A PERMANENT RADIOGRAPHIC INSTALLATION

REQUIREMENTS:

1. At least two qualified radiographers shall be assigned to operations at a temporary job site.

2. At least two operable and calibrated RASP approved low-range survey meters, which meet the range requirements of 2 mrem/hour to 1,000 mrem/hour, shall be available at the temporary job site (AN/PDR-43s do not satisfy this requirement).

3. A physical barrier shall be established at the point where the radiation level is two mrem in any one hour for the number and conditions of exposure. This restricted area barrier shall be conspicuously posted with signs containing the radiation symbol and the words "Caution – Radiation Area". This in effect moves the radiation area

(normally defined as any area where a major portion of the body could receive in any one hour a radiation dose in excess of five mrem in any one hour or 100 mrem in any five consecutive days) outward to coincide with the restricted area boundary. These signs shall be visible to any person approaching the radiation area barrier from any direction. The following information shall be added to the above sign to aid in identifying radiation hazards; "Radiography in Progress – Keep Out Unless Authorized by Radiographer-in-Charge".

4. The areas in which the radiation level is calculated to be 100 mrem in any one hour for the number and conditions of exposure shall be controlled with rope, tape, or other barrier and posted with "Danger – High Radiation Area" signs if the source is iridium-192 or cobalt-60 with activities equal to or greater than 100 curies or 35 curies respectively, and, with "Caution – High Radiation Area" signs when these sources are of lower activity.

5. After the barriers are established, the restricted area shall be inspected and cleared of all personnel.

6. Radiographic personnel (barrier monitors, radiographers, or radiographers' assistants) shall be assigned as required to maintain control and surveillance of the entire restricted area boundary. All restricted area boundaries protecting areas from which it is possible to enter into a high radiation area shall be under constant and continuous direct surveillance. Control and surveillance of the restricted area boundary shall be maintained at ALL times that the boundary is established and posted. Radiographic personnel assigned to this task shall not leave assigned positions while the source is exposed except in sudden life threatening situations.

7. During the first exposure and when set-up conditions change, the restricted area perimeter shall be surveyed and adjusted accordingly.

8. The radiographer-in-charge shall assure positive communication is maintained with each individual assigned to control the restricted area boundary. Positive communication may be established by whistle, lights or two-way communication equipment.

9. The radiographer-in-charge shall maintain control of the restricted area boundary by direct observation or by positive communication.

10. Upon determining that the restricted area boundary has been penetrated:

- a. Barrier monitors shall immediately notify the radiographer-in-charge.
- b. The source shall immediately be retracted and locked in the exposure device until the area is clear of personnel and operations are ready to resume.

11. If entry to a restricted area by non-radiographic personnel is required for any reason during ongoing radiography operations, the following actions shall be taken:

- a. Ensure that the source is secured in the exposure device.
- b. Verify that radiation levels do not exceed the limits for an unrestricted area unless personnel dosimetry requirements are in compliance with Chapter 6, NAVMED P-5055.
- c. Remove or drop barrier rope or tape at entrance point.
- d. Remove or cover radiation caution signs at entrance point.
- e. Maintain strict accountability for all personnel entering the area to ensure that the area is clear before radiography is resumed. If a portion of the posted area is left unguarded during the interval between radiographic exposures, the entire area must be thoroughly searched prior to resumption of radiographic operations to verify that unauthorized personnel are not inside the posted boundaries.

3.3.7 PERMANENT RADIOGRAPHIC INSTALLATIONS

REQUIREMENTS:

1. PHYSICAL REQUIREMENTS

- a. Each entrance or access point to a high radiation area shall be either:

(1) Equipped with a control device which, upon entry, shall reduce the radiation level below that at which an individual could receive 100 mrem in one hour;

OR

(2) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the licensee or a supervisor of the activity are made aware of the entry;

OR

(3) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

- b. The high radiation area controls above shall be established such that an individual shall have a suitable means of exit from the high radiation area without delay.

c. Each personnel entrance to a high radiation area in a permanent radiographic installation which is not controlled per paragraph 1.a above shall be equipped with visible and audible warning signals.

(1) The visible signal shall be actuated by radiation whenever the source is exposed.

(2) The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

(3) The warning signals shall be tested at intervals not to exceed three months and prior to the first use of a radiographic source in the installation. The latter test also satisfies the former. Records of the test shall be maintained for three years.

d. The interior of the installation shall be posted with signs containing the conventional magenta or purple three bladed radiation symbol and the words "Danger – High Radiation Area" on a yellow background when using an iridium-192 or cobalt-60 source with an activity equal to or greater than 100 curies or 35 curies respectively, and, with "Caution – High Radiation Area" signs when these sources are of lower activity. Sufficient signs and the placement of the signs shall be such that the signs are conspicuously visible to anyone entering the installation.

e. All entrances to the installation shall be posted with a sign containing the conventional magenta or purple three-bladed radiation symbol and the words "Caution – Entering Radiation Exposure Room" on a yellow background.

f. Additional information may be added to the signs above which will aid individuals in identifying radiation hazards (e.g., Danger – High Radiation Area When Red Light Is Flashing).

g. The radiation level in any accessible unrestricted area at one foot from the outside surface of the installation shall not exceed two mrem in any one hour. The radiation level in any normally occupied area shall be such that an individual would not exceed 100 mrem in seven consecutive days or 500 mrem in one year.

h. Any radiographic source placement limitations required to meet the restrictions of paragraph g above shall be marked in a permanent manner on interior surfaces (e.g., painted lines on the floor).

i. Any limitations of the source strength or other operational limitations required to meet the limits of paragraph g above shall be posted in a conspicuous and permanent manner on a sign at the entrance to the installation.

2. OPERATIONAL REQUIREMENTS

a . Prior to the first exposure of the day, the radiographer shall check any control devices for proper operation. Records of such checks shall be maintained for three years.

b. During the first exposure of the day or shift, the radiographers shall observe the proper operation of any warning systems. Records of such checks shall be maintained for three years.

c. After a radiographic exposure, the radiographer shall use a calibrated operable survey instrument during entry into the installation and shall survey the exposure device and entire circumference of the source guide tube to determine that the radiographic source was returned to the shielded position.

3.3.8 PROCUREMENT AND RECEIPT OF RADIOGRAPHY SOURCES

REQUIREMENTS:

1. RSO approval shall be obtained prior to the procurement of radiographic sources.

2. When receipt of a radiographic source is anticipated, the RSO shall coordinate with the local supply department or Naval Supply Center to effect prompt notification and expeditious pickup and proper receipt of the source. Coordination shall include the following:

a. Providing and maintaining a current list of designated personnel to be notified to the supporting supply department or Naval Supply Center.

b. Ensuring that a current copy of the NRMP has been provided prior to the expected receipt.

c. Briefing appropriate supply personnel on identification of the radiographic source package prior to each expected receipt.

d. Verifying the availability of secure, properly posted storage within the supply activity.

e. Arranging for pickup of the source from a supporting supply center immediately upon notification of its arrival. The Supply Center shall be notified if immediate pickup cannot be accomplished.

f. Arranging for pickup of the radiographic source within three hours if received by the local supply department.

3. Upon receipt, the radiographic package shall be monitored by the RSO in accordance with 10 CFR 20.205. Normally this shall be accomplished by the RSO of the requisitioning activity. However, when the source is received at a Supply Center and immediate pickup is not possible, as described in Article 3.3.8.2.e above, the required monitoring shall be accomplished by the Supply Center RSO. The requisitioning activity RSO shall coordinate this requirement with the Supply Center RSO.

3.3.9 RECORDS AND REPORTS

REQUIREMENTS:

1. All situational and periodic reports required by 10 CFR which would be made to the NRC shall be made to CNO (OP-45) with copies to NAVSEASYS COM (SEA-06GN) and NAVSEADET RASO as specified in Section 2.10 and the conditions of the NRMP.

2. In addition to the situational and periodic reports required by 10 CFR, Naval commands authorized by a NRMP to conduct gamma radiography shall inform NAVSEADET RASO by telephone (AUTOVON 953-4692, Commercial 804-887-4692), or by priority message if at sea, within one working day of the occurrence of any of the events listed in 10 CFR 34.30.

a. Boundary violations as follows:

(1) Violations of a high radiation area boundary or of a radiation area boundary which would allow unimpeded access to a high radiation area.

(2) Violations of a radiation area boundary which results in a calculated or measured exposure of two mrem or greater to any individual.

NOTE

Violations of radiation area boundaries which neither allow unimpeded access to a high radiation area boundary nor result in an actual exposure to personnel of two mrem or greater do not require reporting. However, these events will be documented and retained locally for review by NAVSEADET RASO on the next RASO inspection. These files may be destroyed after the review.

b. Inability to retract a source to a shielded position or extend the source for any reason, other than failure of the operator to unlock the exposure device or crank mechanism.

c. Occurrence of any of the events listed in 10 CFR 34.40 and any of the following events: exposure equipment malfunctions such as: drive cable coming off the drive mechanism, drive cable binding which seriously impedes source movement, and failure of guide tube stop.

d. Significant violations of procedures during source manipulation such as: failure to hook up guide tube, failure to place source stop on guide tube, failure to lock the exposure device prior to moving the exposure device, failure to wear required dosimetry, and failure to immediately retract the source upon notice that a boundary penetration has occurred.

e. Any unplanned exposure to a radiographer, or others, caused by failure to retract the source, failure to conduct surveys to verify retraction, or use of improper storage areas.

f. Any significant mislocation or miscalculation of the radiation area boundary. In the case of a calculated 2 mrem per hour boundary, report instances where actual exposure levels exceed 20 mrem per hour at the radiation area boundary.

g. Actual exposure of an individual in an unrestricted area to greater than two mrem in any one hour.

h. Potential exposure of an individual in an unrestricted area to greater than two mrem in any one hour as determined by using the observed or calculated exposure rate and duration of exposure, whether or not anyone was actually exposed.

3. Verbal and message reports shall be followed, within 15 days of the problem occurrence, by a written report detailing the problem and shall include actions planned to prevent recurrence. If the event is reportable to NRC by 10 CFR 34.30, the written report shall include all information required by 10 CFR 34.30 (b), and shall be forwarded directly to CNO (OP-45) with a copy to NAVSEADET RASO. Written reports of all other events shall be forwarded directly to NAVSEADET RASO as follows:

MAILING ADDRESS:

Officer In Charge
Naval Sea Systems Command Detachment
Radiological Affairs Support Office (RASO)
Yorktown, VA 23691-5098

MESSAGE ADDRESS:

NAVSEADET RASO YORKTOWN VA//00//

TELEPHONE:

AUTOVON: 953-4692

Commerical: (804) 887-4692

Telefax: (804) 887-3235

4. Each command or activity that conducts gamma radiography shall establish and maintain a pocket dosimeter log(s).

5. Pocket dosimeter logs shall be retained at least three years.

6. The pocket dosimeter log shall contain the following information as a minimum:

- a. Command or activity name.
- b. Date of issue of the pocket dosimeter.
- c. Name of individual to whom issued.
- d. Dosimeter serial number.
- e. Initial pocket dosimeter reading.
- f. Final pocket dosimeter reading.
- g. Net pocket dosimeter reading (final minus initial).

7. Entries in the pocket dosimeter log shall be made in ink.

8. Pocket dosimeter log entries are only required on days when gamma radiography is actually being conducted and only for those pocket dosimeters actually used. A sample pocket dosimeter log is attached as Appendix D.

9. Utilization logs shall be maintained for each permanent facility used by the command or activity and for each operation conducted outside of a permanent facility.

10. Utilization logs shall be retained indefinitely.

11. Utilization log format shall be determined locally to allow for unique requirements.

12. Utilization logs used in a permanent facility shall contain, as a minimum, the following information:

- a. A description (make and model number) of the radiographic exposure device or storage container in which the sealed source is located.

- b. The curie strength of the source on the day of exposure.
- c. The name(s) of the radiographer(s), and signature of the Senior Radiographer.
- d. The make and serial number of the RADIAC survey instrument(s) in use.
- e. Initials of the radiographer verifying that the RADIAC survey instrument(s) has or have been source checked prior to the initial exposure of the day or shift as appropriate.
- f. The duration of each exposure.
- g. The location of the facility.

13. Utilization logs used in other than permanent facilities shall contain the following minimum information:

- a. All required items of paragraph 12 above.
- b. A sketch of the operation area for each exposure or group of repetitive exposures which shows:
 - (1) Layout of equipment in the area (control assembly, exposure device, and source stop).
 - (2) Significant structural features which may provide attenuation of the beam.
 - (3) Approximate high radiation area barrier distance from the exposed source.
 - (4) Approximate radiation area barrier distance from the exposed source.
 - (5) Actual exposure rate as observed by radiation barrier monitors at a minimum of four points on the radiation area barrier.
 - (6) Exposure rate at the control assembly with source extended.
- c. The names of the radiation barrier monitor(s).

14. Each permittee shall conduct a quarterly physical inventory to account for all non-exempt sealed sources received and possessed under their permit. Inventory records shall be maintained for as long as the source is retained, and for three years following disposition of the source.

BLANK

SECTION IV

X-RAY RADIOGRAPHY

4.1 GENERAL

DISCUSSION:

Industrial x-ray radiography represents a potential for serious radiation exposure to x-ray radiography personnel and members of the general public in the vicinity of x-ray radiography operations. Because of this potential for personal injury, it is incumbent upon each Navy and Marine Corps activity that conducts x-ray radiography to operate their programs in strict compliance with established radiation safety rules. This section provides minimum standards for industrial x-ray radiography radiation safety. The radiation safety requirements listed herein for x-ray radiography are the minimum which each Navy and Marine Corps activity must meet. Individual commands are encouraged to establish additional radiation safety requirements for their respective operations as dictated by local conditions.

4.2 GENERIC REQUIREMENTS FOR CONDUCTING RASP X-RAY RADIOGRAPHY

DISCUSSION:

The requirements of this part shall be observed when conducting x-ray radiography in any of the three classifications of facilities; i.e., exempt shielded, shielded, and open.

REQUIREMENTS:

1. Commanding Officers shall establish, in writing, and implement a RASP Radiological Controls Program. A qualified RSO and ARSO shall be designated in writing. The authority of the RSO to immediately halt any RASP operations he considers unsafe, and his direct access to the Commanding Officer on matters dealing with radiation safety shall be clearly stated.

2. Locally established radiological controls programs shall include necessary details to implement the requirements of this manual. As a minimum, the local directive shall include assignment of responsibilities; detailed operating and emergency procedures; and local training or orientation on radiation safety for supervisors, workers, emergency response personnel and visitors.

3. A qualified x-ray radiographer shall operate the x-ray console.

4. The x-ray tube head, cables and console shall be checked for obvious defects prior to the first use at the beginning of each shift.

5. Command approved operating and emergency procedures shall be available in the vicinity of the x-ray console. Article 4.7 of this section cites operating and emergency procedures content and format.

6. A utilization log shall be maintained by the x-ray radiographer. Article 4.9 of this section cites specific log content.

7. All personnel participating in the x-ray radiography operations shall wear two IM-235 series self-indicating pocket dosimeters and an approved primary dosimeter as specified in NAVMED P-5055.

8. IM-235 series pocket dosimeters shall be charged at the start of the shift when x-ray radiography is to be conducted. The initial readings shall be recorded in the pocket dosimeter log. Article 4.9 of this section cites pocket dosimeter log content.

9. At the completion of the shift or final x-ray radiography operation of the day, final and net readings of the pocket dosimeters shall be recorded in the pocket dosimeter log. Appendix D of this manual cites sample pocket dosimeter log.

10. RASP approved radiation survey instruments as discussed in Article 4.6 of this section shall be used for x-ray radiography radiation surveys.

11. Radiation survey instruments to be used in the x-ray radiography operation shall be source checked for proper response to radiation, following the NAVSEASYS COM (SEA-04R) provided procedures, prior to the first use of the day or shift. Instruments that fail to respond within the acceptable response range shall not be used until they have been returned to the calibration facility for re-calibration or repair. Satisfactory source checks shall be annotated on the utilization log.

12. There shall be at least one RASP approved, calibrated, and operating radiation survey instrument located at the control panel at all times when x-ray radiography is being performed.

13. Prior to the first exposure of the day or shift, all interlocks and warning or emergency devices shall be checked for proper operation and the results annotated on the utilization log as discussed in paragraph 4.9.2.

14. The interlock check shall be performed by actually tripping the interlock while operating the equipment at low kVp and mA. The interlock must terminate the exposure

and be so wired that merely reclosing the door will not result in the resumption of x-ray production until the control panel has been reset.

15. X-ray control panels shall be equipped with a key switch which shall prevent the production of x-rays when placed in the "off" position. The "on" and "off" position of the key switch shall be clearly marked and the key shall be removable only when the switch is in the "off" position.

16. Whenever an exposure is not actually in progress, including set-up in between exposures, the x-ray radiographer shall remove the key from the console and maintain personal custody until the next exposure is made.

17. Whenever x-ray equipment is not actually in use, it shall be secured to prevent use by unauthorized personnel. As a minimum, the control panel switch key shall be removed.

4.3 EXEMPT SHIELDED FACILITIES

4.3.1 PHYSICAL REQUIREMENTS

An installation shall be classified as an exempt shielded facility when it conforms with all of the following requirements:

1. The x-ray tube head and all objects to be irradiated are within a permanent structure within which no person is permitted to remain during irradiation.

2. Fail-safe audible and visible warning signals shall be located within the structure and activate a minimum of 20 seconds before x-rays are to be produced. The visible signal (preferably a rotating beacon) must remain illuminated during x-ray production.

3. A suitable means of exit shall be available so that any person who may be accidentally shut in can leave the structure without delay.

4. A means shall be available within the enclosure to prevent or quickly interrupt the x-ray production. The device inside the enclosure shall require manual resetting to enable the reinitiation of x-ray production. The use and function of the device shall be clearly labeled.

5. Each entrance or panel providing access to the enclosure shall have fail-safe interlocks installed or shall be locked from inside the facility to prevent access from outside the x-ray exposure facility.

6. The exposure rate at two inches from any accessible surface outside of the facility shall not exceed 0.5 mR per hour. This exposure rate shall be determined during

initial evaluation of the facility, re-evaluation of the facility, and during all periodic radiation protection surveys.

NOTE:

Surveys to determine exposure rates shall be conducted with the x-ray machine at maximum output and the unattenuated primary beam directed at each of the six barriers in turn at a target-to-barrier distance (TBD) of 36 inches (if design restrictions preclude a TBD of 36 inches, the closest possible distance will be used) for the four bulkheads and the deck, and the closest practical distance for the overhead.

7. The interior of the facility shall be posted with signs containing the conventional magenta or purple three-bladed radiation symbol and the words "Danger – High Radiation Area" on a yellow background. There must be sufficient signs to be visible by anyone entering the facility.

8. All entrances to the facility shall be posted with a sign containing the conventional magenta or purple three-bladed radiation symbol and the words "Caution – Entering Radiation Exposure Room" on a yellow background.

9. All entrances to the facility shall have a light outside which is illuminated simultaneously with x-ray production. This light may be an illuminated sign reading "X-Ray ON" or a flashing light with a sign or label indicating "X-Ray ON When Lit".

4.3.2 OPERATIONAL REQUIREMENTS

To conduct exempt shielded facility x-ray radiography operations, the following requirements must be met in addition to those generic requirements found in Article 4.2.

1. Prior to the first exposure of the day or shift, all interlocks and warning or emergency devices shall be checked for proper operation.

2. During machine warmup or the first exposure of the day, a quick scan radiation survey and visual check shall be made of the primary personnel or equipment access door(s) to ensure that door overlaps and deck coamings are intact and radiation streaming is not evident.

3. Whenever an exempt shielded facility is entered after an x-ray exposure, the first person entering the facility shall use the radiation survey instrument to ensure that x-ray production has ceased.

4.4 SHIELDED FACILITIES

4.4.1 PHYSICAL REQUIREMENTS

An installation shall be classified as a shielded facility when it conforms with all the following requirements:

1. The x-ray tube head and all objects to be irradiated are within a permanent structure, within which no person is permitted to remain during irradiation.

2. Each entrance or panel providing access to the shielded facility must have fail-safe interlocks installed or must be locked from inside the facility to prevent access from outside the x-ray exposure facility.

3. If the enclosure is very large or is configured such that the operator cannot readily ensure that the enclosure is unoccupied, there shall be provided:

- a. Internal fail-safe audible and visible warning signals that activate a minimum of 20 seconds before x-rays may be produced. The visible signal (preferably a rotating beacon) shall remain illuminated during x-ray production.

- b. A suitable means of exit so that any person who may be accidentally shut in can leave the structure without delay.

- c. A means within the enclosure to prevent or quickly interrupt the x-ray production. The device inside the enclosure must be manually reset to enable the reinitiation of x-ray production. The use and function of the device shall be clearly labeled.

4. The exposure rate in any accessible unrestricted area at one foot from the outside surface of the facility shall not exceed 2 mR in one hour. The exposure rate in any normally occupied area around the facility shall be such that a person would not exceed 100 mR in seven consecutive days or 500 mR in one year.

5. The interior of the facility shall be posted with signs containing the conventional magenta or purple three-bladed radiation symbol and the words "Danger – High Radiation Area" on a yellow background. There must be sufficient signs to be visible by anyone entering the facility.

6. All entrances to the facility shall be posted with a sign containing the conventional magenta or purple three-bladed radiation symbol and the words "Caution – Entering Radiation Exposure Room" on a yellow background.

7. All entrances to the facility shall have a light outside which is illuminated simultaneously with x-ray production. This light may be an illuminated sign reading "X-Ray ON" or a flashing light with a sign or label indicating "X-Ray ON When Lit".

8. Each of the six barriers (four bulkheads, deck and overhead) shall be clearly stenciled with their classification as a primary barrier or secondary barrier. Any barrier labeled as a secondary barrier shall also be stenciled with the words "Do Not Irradiate With Primary Beam".

4.4.2 OPERATIONAL REQUIREMENTS

To conduct shielded facility x-ray radiography operations, the following requirements must be met in addition to those generic requirements found in Article 4.2.

1. Prior to the first exposure of the day or shift, all interlocks and warning devices shall be checked for proper operation.

2. During machine warmup or the first exposure of the day, a quick scan radiation survey and visual check shall be made of the primary personnel or equipment access door(s) to ensure that door overlap and deck coamings are intact and radiation streaming is not evident.

3. Whenever the shielded facility is entered after an x-ray exposure, the first person entering the vault shall use the radiation survey instrument to ensure that x-ray production has ceased.

4. Any restrictions on x-ray machine settings (i.e., do not exceed 120 kVp, 5 mA) or tube head orientation shall be durably and obviously posted at the x-ray console.

5. Prior to initiating an x-ray exposure, the radiographer shall personally inspect the facility to ensure that no one remains inside.

4.5 OPEN FACILITIES

DISCUSSION:

Explosive ordnance operations using portable pulsed x-ray units of 150 kVp or less are excluded from this section but are required to follow safety procedures in the manufacturers' technical manuals.

4.5.1 PHYSICAL REQUIREMENTS

If a facility, enclosure, or open area does not meet the more restrictive requirements for an exempt shielded or shielded facility, then it shall be considered an open facility and is subject to the following physical requirements:

1. The x-ray tube head and all objects to be irradiated must be within a conspicuously posted perimeter that limits the area in which the exposure rate can exceed 100 mR per hour. This area shall be designated the high radiation area.

NOTE:

HIGH RADIATION AREA BOUNDARIES SHALL BE CALCULATED ONLY. Verification surveys shall not be performed.

2. The high radiation area barrier shall be conspicuously posted with signs containing the conventional magenta or purple three-bladed radiation symbol and the words "Danger – High Radiation Area" on a yellow background. These signs must be visible to anyone approaching the high radiation area from any accessible route.

3. The perimeter of the high radiation area shall be a physical barrier established by an enclosure or by stanchions and yellow, or yellow and magenta, rope as necessary.

4. A second physical barrier shall be established at the point at which the exposure rate equals two mrem in any one hour. This barrier shall be conspicuously posted with signs containing the radiation symbol and the words "Caution: Radiation Area". This in effect moves the radiation area (normally defined as any area where a major portion of the body could receive a radiation dose in excess of five mrem in any one hour or 100 mrem in any five consecutive days) forward to coincide with the restricted area boundary. These signs shall be visible to any person approaching the radiation area barrier from any accessible direction.

5. There shall be located next to the tube head a rotating or flashing red light and warning sign stating "X-RAY ON When Lit". The warning light shall be interlocked to the x-ray console so that it is illuminated when x-rays are produced.

NOTE:

The red warning light is not required during hangar deck or flight deck operations at sea, or when it might compromise flight line safety.

4.5.2 OPERATIONAL REQUIREMENTS

To conduct open facility x-ray radiography operations, the following requirements are mandatory in addition to the generic requirements of Article 4.2.

1. The command RSO shall be notified of the time and location of planned open facility x-ray operations. The RSO shall ensure that notification of the x-ray radiography operations is made to activities and personnel who will be in immediate proximity to the radiation area.

2. There shall be a MINIMUM of two RASP approved, calibrated and operating radiation survey instruments. One shall be at the operator's console and the other used to verify the radiation area boundary (2 mR per hour line).

3. Prior to the first exposure and warmup of the day or shift, the following shall be accomplished:

a. High radiation area and radiation area boundaries shall be calculated and posted with the required signs.

b. Radiation barrier monitors shall be briefed on their responsibilities and issued necessary radiation survey instruments and appropriate communications equipment.

4. Whenever the tube head is approached after an exposure, the first person in shall carry a RASP approved, calibrated and operating, x-ray radiation survey instrument to ensure the tube head is not producing x-rays.

5. When the x-ray machine is energized and producing x-rays, those personnel so designated shall survey the radiation area boundary and adjust it as necessary to ensure that no reading above two mR per hour is noted. If beam orientation or technique factors change between exposures, the radiation area boundary must be re-established and verified by surveys. **UNDER NO CIRCUMSTANCES SHALL THE HIGH RADIATION AREA BOUNDARY BE SURVEYED.**

6. When conducting x-ray exposures on large objects such as on aircraft or sonar domes, the x-ray radiographer, **PRIOR TO X-RAY PRODUCTION, SHALL PHYSICALLY CHECK THAT NO ONE REMAINS IN THE OBJECT TO BE EXPOSED.**

7. The x-ray radiographer shall maintain constant surveillance of the entire radiation area boundary either through direct observation or by **POSITIVE COMMUNICATION** with radiation barrier monitors who are in position to provide visual surveillance. The intent of this requirement is to enable the radiographer to immediately shut down x-ray production if a person penetrates the radiation area boundary.

8. Immediately upon determining that the radiation area has been penetrated, the x-ray radiographer shall cease production of x-rays.

4.5.3 FLIGHT DECK OR HANGAR DECK X-RAY RADIOGRAPHY REQUIREMENTS

Periodically, x-ray radiography is required on the hangar deck or flight deck of CV, LHA, LPH and LHD type ships. Shipboard conditions of occupancy and work areas dictate that special requirements be established to ensure radiation safety.

1. All requirements for open facility x-ray radiography shall be adhered to without deviation except that the flashing red light is not required at the x-ray tube head for at-sea operations.
2. Whenever possible, x-ray radiography shall be conducted on a deck-edge elevator with the elevator on the hangar deck level.
3. Whenever conducting x-ray radiography with horizontal orientation of the primary beam, the primary beam shall be directed outboard to sea such that it does not intersect any portion of the ships's structure, or an adjacent ship.

NOTE:

During horizontal beam orientations, extreme caution must be exercised because the two mR per hour boundary can extend several hundred feet.

4. During flight deck x-ray radiography aboard LHA, LPH and LHD type ships, the x-ray primary beam shall never be aimed directly at the flight deck. On these classes of ships, the thickness and composition of the flight deck allows a radiation area in the spaces immediately below.
5. During hangar deck x-ray radiography operations, extra vigilance (including assigning extra radiation barrier monitors as necessary) shall be provided because the number of unlocked access hatches and doors facilitates ship's personnel inadvertently venturing into the radiation area.

4.6 SURVEY INSTRUMENTS AND PERSONNEL DOSIMETRY

4.6.1 RADIATION SURVEY INSTRUMENTS

REQUIREMENTS:

1. All x-ray radiography activities shall conduct radiation protection surveys with RASP approved x-ray radiation survey instruments having a range of two mR to at least one R (1000 mR) per hour. The authorized Navy and Marine Corps instrument is the

IM-231 PD series ionization chamber, which includes the IM-231-PD (Cutie Pie), IM-231A-PD (BICRON RSO-5) and the IM-231B-PD (Eberline RO-2). Other ionization chambers are acceptable such as the Victoreen 440, however the Navy RADIAC Program Office (NAVSEA-04R) is currently only procuring IM-231A-PD and IM-231B-PD instruments. If a commercial instrument is procured, the Navy Calibration Laboratory is not required to support it.

2. RASP approved radiation survey instruments shall be calibrated at three month intervals and after each repair or servicing.

3. Uncalibrated radiation survey instruments, or those whose last calibration date exceeds three months, shall not be used. Extraordinary situations which prevent compliance with the required calibration cycles shall be resolved by the type command for fleet units, and NAVSEADET RASO for shore activities.

4. Radiation survey instruments shall be checked for acceptable response to radiation using the provided check source prior to the first operation of the day or shift, and after suspected damage such as would occur if dropped.

NOTE:

Check source exposure rate values are included on RADIAC calibration certificates provided by the supporting Navy Calibration Laboratory.

5. Under no circumstance shall Geiger-Mueller (GM) tube type instruments such as the AN/PDR-27 be used during x-ray operations or x-ray radiation protection surveys. The response of GM-type instruments to the relatively low effective energies typically used for x-ray radiography is extremely variable and includes severe over and under response. This extreme variability could lead to serious personnel overexposures.

6. When using the IM-231A-PD or IM-231B-PD to survey x-ray machines operating below 120 kVp, the sliding window (beta window) on the base of the instrument shall be opened and the open window pointed at the area to be surveyed. This procedure compensates for the inherent under-response of the instrument to average x-ray energy of 40 keV and below.

4.6.2 POCKET DOSIMETERS

REQUIREMENTS:

1. When conducting x-ray exposures, all x-ray radiographers and radiation barrier monitors shall wear two self-indicating pocket dosimeters of the IM-235 series or commercial equivalent having a range of 0-200 mR in addition to the TLD. In the

event of documented shortages beyond the control of the using command, the RSO may grant written authorization to temporarily use one pocket dosimeter per person. Issued pocket dosimeters shall have a current calibration sticker attached (NOTE: Re-calibrations are required every six months).

2. Under no circumstances shall x-ray radiography personnel wear the IM-9 series pocket dosimeter during x-ray operations. The IM-9 series does not accurately measure the large component of low-energy x-rays produced in x-ray machines.

3. Pocket dosimeters shall be worn adjacent to the individual's approved primary dosimeter.

4. Pocket dosimeters shall be zeroed at the start of each shift during which personnel will actually conduct x-ray radiography. Absolute zero need not be attained. However, it should be adjustable to read less than 10 mR. If it cannot be brought to read less than 10 mR, attempt to rezero it on another charger. If it still does not read less than 10 mR, it shall be rejected and returned to a calibration facility for evaluation.

5. Pocket dosimeters shall be read often during the shift. The initial, final and net readings for pocket dosimeters shall be recorded in a pocket dosimeter log. A sample pocket dosimeter log is attached as Appendix D.

6. Pocket dosimeters determined to go off-scale or drift prior to the first actual x-ray production of the day or shift shall be considered defective and shall not be treated as off-scale pocket dosimeters. They shall be withdrawn from use and turned in to the servicing calibration facility for evaluation.

7. Pocket dosimeters found to be off-scale during or after x-ray radiography operations require immediate action to evaluate and minimize possible personnel exposure.

8. If only one pocket dosimeter goes off-scale, the individual shall immediately be removed from radiation work. The primary dosimetric device shall be immediately returned to the Naval Dosimetry Center for evaluation. The Dosimetry Center shall be contacted by telephone or naval message to ensure proper routing is achieved. The individual may be allowed to return to work before the results of the primary dosimetric evaluation are known if ALL of the following conditions are met:

a. The RSO can clearly establish that the off-scale pocket dosimeter is defective (See paragraph 4.6.2.9 below).

AND

b. The pocket dosimeter which was not off-scale is functioning properly (see paragraph 4.6.2.9 below) and reads less than 10 mR.

AND

c. The RSO has determined that the individual was not exposed beyond the permissible limits in NAVMED P-5055 or established administrative limits.

9. The following checks shall be performed on both dosimeters (NOTE: Facilities with a RADIAC Calibration Laboratory shall perform a response check using NAVSEASYSKOM (SEA-04R) procedures):

a. **DRIFT CHECK.** Charge to zero, then observe after two hours. Within the context of this procedure, a defective pocket dosimeter is one that undergoes greater than one-fourth of full scale deflection (upward drift) within two hours.

b. **RESPONSE CHECK.** If the pocket dosimeter passes the drift check then a response check shall be performed as follows:

(1) Ensure that the pocket dosimeter has a current calibration sticker attached (NOTE: Re-calibrations are required every six months).

(2) Zero the pocket dosimeter to be checked.

(3) Tape the side of the sensitive end of the pocket dosimeter to a cesium-137 check source such as those used for the radiography survey meters.

(4) After two hours, read the pocket dosimeter.

(5) Any upscale reading indicates a positive response and the dosimeter is considered good.

(6) If no upscale reading is noted, the pocket dosimeter shall be considered defective.

10. If both pocket dosimeters go off-scale or if only one goes off-scale and the other indicates a radiation exposure of greater than 10 mR, the individual shall not be permitted to return to radiation work until the results of the primary dosimetric device evaluation are known.

4.6.3 PRIMARY PERSONNEL DOSIMETERS

REQUIREMENTS:

The requirements of Chapter 6 of NAVMED P-5055 shall be followed for use of thermoluminescent dosimeters.

4.7 RADIATION SAFETY OPERATING AND EMERGENCY PROCEDURES

DISCUSSION:

The purpose of requiring written operating and emergency procedures is to provide x-ray radiography personnel with clear and specific requirements and actions to maintain a radiation safety program.

REQUIREMENTS:

Operating and emergency instructions shall:

1. Be written for each x-ray facility at the command and include the procedures for each type of machine installed and used in that facility.
2. Be command endorsed either as a command instruction or section or enclosure to a command instruction. If issued as a departmental directive, they shall contain a command approval.
3. Be specific to the x-ray machine and facility but should not be a reprint of manufacturer's operating manuals.
4. Incorporate those radiation safety control requirements for the facility as listed in applicable portions of Parts 2, 3, 4 and 5 of this section.
5. Contain current and accurate information on persons to be notified in the event of an accident and specify method of notification.
6. Require coordination of x-ray operations with the command RSO.
7. Contain the steps that must be taken immediately by x-ray radiography personnel in the event a pocket dosimeter is found to be off-scale.
8. Contain a specific provision or caution that when conducting open facility x-ray radiography, the boundary of the high radiation area shall be calculated and never actually surveyed.
9. Contain a requirement to maintain direct surveillance of the high radiation area boundary except where the high radiation area is equipped with a control device or alarm system or where the high radiation area is locked to protect against unauthorized or accidental entry.
10. Specify logs and records to be maintained by radiography personnel.

11. Specify key control and machine security requirements to prevent inadvertent operations by unauthorized personnel.

12. Contain a statement that only qualified x-ray radiographers shall conduct x-ray radiography operations.

13. Contain a statement and commitment that AT LEAST ONE qualified x-ray radiographer and one radiation barrier monitor shall be on station where radiography is conducted as open facility operations. Additional barrier monitors shall be assigned as required to maintain complete surveillance of the radiation area boundaries.

14. Contain a requirement that the radiographer shall not unlock or enable the x-ray control panel until ready to energize the x-ray unit.

15. Be posted if practicable, otherwise be readily available at the control panel.

4.8 RADIATION PROTECTION INSPECTIONS AND SURVEYS

DISCUSSION:

Radiation protection surveys and inspections are necessary to ensure that Navy and Marine Corps x-ray radiography is conducted in accordance with established radiation safety procedures and parameters.

4.8.1 RADIATION PROTECTION INSPECTIONS

REQUIREMENTS:

1. Radiation protection inspections shall be conducted and documented for all facilities classified as exempt shielded or shielded as follows:

a. Unannounced, at a frequency not to exceed every six months for operating facilities.

b. Prior to regular operations in a fixed facility which has been inoperative or not in use for over six months.

2. The radiation protection inspection shall be conducted by the RSO or other qualified individual.

3. Radiation protection inspection reports shall be signed by the person conducting the inspection, and reviewed and initialed by the RSO. They shall be maintained on file for a period of three years.

4. Radiation protection inspection reports shall contain the following minimum information:

a. General

- (1) Identification of the person conducting the inspection.
- (2) Identity of the facility; i.e., room number, building number.
- (3) Classification of the facility; i.e., exempt shielded, or shielded.

b. Fixed Facilities (Exempt Shielded and Shielded)

(1) A diagram of the facility showing all adjacent areas with present occupancy of adjacent offices or spaces.

(2) A listing of audible and visible warning signals, interlocks, delay switches and mechanical and electrical devices that restrict the x-ray beam, and verification of their operational status.

(3) Verification that all required signs and labels are affixed and legible.

(4) The results of a quick scan radiation survey to be conducted as follows:

(a) The x-ray machine shall be operated at maximum authorized operating parameters as stated in the latest facility evaluation.

(b) The target-to-primary barrier distance shall be 36 inches. If design restrictions preclude a target-to-primary barrier distance of 36 inches, the closest possible distance will be used.

(c) The primary beam shall be directed at each of the primary barriers, which have personnel or equipment access doors, in turn and the maximum exposure rate outside the irradiated barrier shall be recorded and location of the reading identified. For exempt shielded facilities, the maximum exposure rate shall be determined at two inches from the barrier. For shielded facilities, the maximum exposure rate shall be determined at one foot from the barrier.

c. Open Facilities

(1) Verification that all required equipment (e.g., signs, stanchions, rope, rotating or flashing red light, radiation survey instruments, copy of operating and emergency procedures) is on-hand at the radiography site.

(2) Verification that the utilization log is properly completed.

(3) Verification that all boundaries are properly established and posted.

(4) Actual radiation levels measured at least two points for each side of the radiation area boundary.

(5) Verification that observed operations were in accordance with written operating and emergency procedures.

4.8.2 RADIATION PROTECTION SURVEYS

REQUIREMENTS:

1. Radiation protection surveys shall be conducted and documented for all fixed facilities classified as an exempt shielded or shielded facility as follows:

a. Prior to placing a facility into operation, a survey and initial facility evaluation shall be conducted by the command RSO or ARSO. This survey shall be submitted to NAVSEADET RASO for review and approval prior to placing the facility in routine operation.

b. Every two years for all active fixed facilities.

c. Whenever there is a change in equipment, shielding, workload, occupancy or procedures which could adversely affect radiation safety, the RSO or ARSO shall conduct a radiation protection survey and submit it to NAVSEADET RASO for re-evaluation of facility classification.

d. When obvious damage occurs, such as shielding cold flow, warping or collapse, or potential damage such as an earthquake in the geographical area, a radiation protection survey shall be conducted regardless of the periodic cycle of the required survey.

e. Nothing in this part precludes more frequent radiation protection surveys based on observed or suspected changes to the integrity of the facility shielding.

2. Radiation protection surveys shall be signed by the RSO and maintained on file indefinitely. If a facility is permanently deactivated, contact NAVSEADET RASO regarding disposition of the applicable radiation protection survey records.

3. Radiation protection survey reports shall contain the following minimum information:

a. Identification of the person(s) conducting the survey and date of the survey.

b. Identification of the x-ray machine(s) used to produce radiation (i.e., make, model, serial number).

c. The identity of the facility (i.e., room number, building number).

d. The present classification of the facility or planned classification for a new facility.

e. Identification of survey instruments used including make, model, serial number and date of last calibration.

f. Description of all pertinent technique factors.

g. A diagram of the facility showing all adjacent areas with present and expected future occupancy of adjacent offices and spaces.

h. A listing of audible and visible warning signals, interlocks, delay switches, mechanical and electrical devices that restrict the x-ray beam, and verification of their operational status.

i. Radiation exposure measurements for all adjacent areas which can be occupied. The measurements shall be made under practical conditions of operation that will result in the greatest exposure at the point of interest. The tube head target-to-primary barrier distance shall be 36 inches. If design restrictions preclude a target-to-primary barrier distance of 36 inches, the closest possible distance shall be used.

(1) For a facility classified as exempt shielded, the survey shall be conducted with the x-ray unit operated at the maximum rating and directed at each of the six barriers.

(2) For a facility classified as shielded facility, the survey shall be conducted in accordance with promulgated or planned operating restrictions such as observation of secondary barrier limitations and operating x-ray machine parameter limitations.

j. A statement that the facility meets or does not meet requirements for its present or requested classification.

(1) If the facility is found to be inadequate, the action projected to correct deficiencies must be stated.

(2) When deficiencies are corrected, a statement to that effect shall be signed by the RSO and attached to the radiation protection survey report.

k. Nothing in this part precludes more frequent radiation protection surveys.

4.9 LOGS AND RECORDS

4.9.1 POCKET DOSIMETER LOGS

REQUIREMENTS:

1. Each command or activity that conducts x-ray radiography shall establish and maintain a pocket dosimeter log.
2. The pocket dosimeter log shall be retained for at least three years.
3. The pocket dosimeter log shall contain the following minimum information:
 - a. Command or activity name.
 - b. Date of issue of the pocket dosimeter.
 - c. Name of person issued to.
 - d. Dosimeter serial number.
 - e. Initial pocket dosimeter reading.
 - f. Final pocket dosimeter reading
 - g. Net pocket dosimeter reading (final minus initial).
4. Entries in the pocket dosimeter log shall be made in ink.
5. Pocket dosimeter log entries are only required on days when x-ray radiography is actually being conducted and only for those pocket dosimeters actually used. A sample pocket dosimeter log is attached as Appendix D.

4.9.2 UTILIZATION LOGS

DISCUSSION:

The x-ray radiography utilization log is an extremely important and valuable record of adherence to radiation safety regulations. It is vital that they be maintained as complete and accurate as possible. The information contained therein must enable reconstruction of the conditions of exposure. The authenticity of the document must be unequivocal.

REQUIREMENTS:

1. Utilization logs shall be maintained for each facility used by the command or activity (i.e., exempt shielded, shielded, open).

2. Utilization logs shall be retained indefinitely.
3. Utilization log format shall be determined at the command or activity to allow for unique local requirements. However, to ensure uniformity and avoid confusion, the following symbols shall be used as the standard for describing x-ray beam orientation:
 - a. ↑ indicates beam aimed up.
 - b. ↓ indicates beam aimed down.
 - c. ↑ indicates beam aimed north or forward.
 - d. ↓ indicates beam aimed south or aft.
 - e. → indicates beam aimed east or starboard.
 - f. ← indicates beam aimed west or port.
4. Utilization logs used in a facility evaluated as an exempt shielded facility shall contain the following minimum information:
 - a. A description of the x-ray machine (i.e., make, model, maximum kVp, mA, etc.).
 - b. The kVp, mA, exposure duration, and date for each exposure, or group of exposures for repetitive work.
 - c. The name(s) of the radiographer(s), and signature of the Senior Radiographer.
 - d. The make, model and serial number of the radiation survey instrument(s) in use.
 - e. Initials of the radiographer verifying that the radiation survey instrument(s) has or have been source checked prior to the initial exposure of the day or shift as appropriate.
 - f. Initials of the radiographer that all interlocks and alarms have been checked for proper operation before the initial exposure of the day or shift as appropriate.
 - g. Maximum reading and location of the reading detected during quick scan radiation survey of primary access doors. Include kVp and mA at which reading was taken.
5. Utilization logs used in a facility evaluated as a shielded facility shall contain the following minimum information:

- a. All required items of paragraph 4 above.
 - b. Beam direction (a sketch of the facility indicating beam direction is recommended) for each exposure or group of exposures for repetitive work.
 - c. Identification of primary and secondary barriers.
6. Utilization logs used in open facility x-ray operations shall contain the following minimum information:
- a. All required items of paragraph 4 above, except items 4.f and g.
 - b. A sketch of the operation area for each exposure which shows:
 - (1) Beam direction.
 - (2) Approximate high radiation area barrier distance from x-ray tube head.
 - (3) Approximate radiation area barrier distance from the x-ray tube head.
 - (4) Actual exposure rate as observed by radiation safety monitors at a minimum of four points on the radiation area barrier.
 - c. The names of the radiation safety monitor(s).

4.9.3 RADIATION SURVEY INSTRUMENT AND POCKET DOSIMETER CALIBRATION RECORDS

REQUIREMENTS:

- 1. Records of calibration of radiation survey instruments used in x-ray radiography shall be maintained on file at the activity for three years from the date of last calibration. The calibration sheet for each instrument which is provided by the cognizant radiation calibration laboratory will suffice for this record.
- 2. Records of pocket dosimeter radiation response checks shall be kept at the activity for six months from the last expiration date. Verification sheets provided by the cognizant radiation calibration laboratory will suffice for this record.

4.9.4 INITIAL FACILITY EVALUATIONS OR FACILITY RE-EVALUATIONS

REQUIREMENTS:

- 1. The formal reports of initial facility survey and any subsequent classification as discussed in Section 4.8.2 shall be retained indefinitely.

2. X-ray operations shall not routinely be conducted unless an approved initial facility evaluation or re-evaluation is on file.

4.9.5 RADIATION PROTECTION SURVEYS AND INSPECTIONS

REQUIREMENTS :

1. The required internal periodic radiation protection surveys and radiation protection inspections shall be maintained on file as follows:

- a. Radiation protection surveys – indefinitely.
- b. Radiation protection inspections – three years.

2. Radiation protection surveys and inspections conducted by NAVSEADET RASO as part of an inspection may be used to meet this requirement providing that they are inclusive of all required items. If the survey or inspection does not contain all items, the command RSO shall provide an addendum that includes the omitted items.

4.9.6 RASP INSPECTION RECORDS

REQUIREMENTS:

1. Records of formal external inspections conducted to evaluate compliance with the Navy and Marine Corps RASP shall be maintained indefinitely.

2. RASP inspection records shall include both the formal inspection report and actions taken to correct items of noncompliance with RASP.

4.9.7 TRAINING

REQUIREMENTS:

Training requirements for x-ray radiography programs are specified in Section II, Part 2.

4.10 REPORT REQUIREMENTS

REQUIREMENTS:

1. In addition to any reports required by Section 2.10.3, naval commands which conduct x-ray radiography operations shall inform NAVSEADET RASO by telephone (AUTOVON 953-4692, Commercial 804-887-4692) within one working day of the occurrence of any of the following during x-ray radiography operations:

- a. Any violations of a radiation area boundary.
- b. Exposure rates which could cause an individual to receive in excess of two mrem in any one hour outside of the posted radiation boundary.
- c. Violations of procedures during x-ray operations which reflect an actual loss of control or significant safety deficiency, such as:
 - (1) Failure to check large equipment for occupancy prior to x-ray production.
 - (2) Allowing unqualified personnel to conduct radiography.
 - (3) Failure to post, survey or control radiation areas.
 - (4) Deliberate unauthorized defeating or bypassing of safety devices.
 - (5) Performing x-ray radiography without using the required primary dosimetric device and pocket dosimeter.
- d. Failure of safety equipment such as interlocks, audible alarms, and interrupt switches during actual operations.
- e. Unplanned exposure to radiographers, or others, caused by improper x-ray tube orientation such that the primary beam is directed at other than a designated primary barrier.

2. Verbal reports shall be followed by a written report detailing the event and shall include actions planned to prevent recurrence. Written reports shall be forwarded within 45 days of the event to NAVSEADET RASO at the following address:

Officer in Charge
Naval Sea Systems Command Detachment
Radiological Affairs Support Office (RASO)
Yorktown, VA 23691-5098

SECTION V

SHORE RADIAC REPAIR FACILITY OPERATIONS

5.1 RESPONSIBILITIES

5.1.1 RASP RADIATION SAFETY OFFICER (RSO)

REQUIREMENTS:

The RSO shall ensure that the following elements of the radiation safety program are accomplished:

1. Physical inventory checks, radiation surveys, and contamination surveys are performed and documented.
2. Operating and emergency procedures are written and updated.
3. Leak tests are performed by qualified personnel as required by conditions of the NRMP.
4. All RADIAC repair personnel receive required initial and refresher radiation safety training.
5. Applications for amendment or renewal of NRMPs are submitted when required by Section II, Part 3 of this manual.
6. All other pertinent requirements and responsibilities of an RSO as specified in this manual are accomplished.

5.1.2 SENIOR RADIAC CALIBRATION TECHNICIAN AND RADIAC CALIBRATION LABORATORY SUPERVISOR

REQUIREMENTS:

The senior RADIAC calibration technician or RADIAC calibration laboratory supervisor shall perform or ensure qualified personnel perform the following functions:

1. Daily, prior-to-use, inspections of calibration sources and related equipment such as interlocks, warning lights, and audible alarms.
2. Inventories and inspections of sources and equipment.
3. Leak tests of calibration sources.
4. Initial and refresher radiation safety training of RADIAC repair personnel.
5. Physical inventory checks, radiation surveys, and contamination surveys of calibration sources and work areas.

6. Contamination surveys of all incoming RADIAC instruments.

7. Notify appropriate personnel, such as the RASP RSO, security, fire department and appropriate supervisors of any planned overnight or unattended calibration operation.

5.2 TRAINING

REQUIREMENTS:

1. The RASP RSO shall be trained in accordance with Section II, Part 2 of this manual.

2. All personnel who operate RADIAC calibrators, directly supervise calibrator operations, or perform leak tests shall complete 40 hours of training in Radiological Health and Safety or the RADIAC Instrument Maintenance Course at Naval Technical Training Center (NAVTECHTRACEN), Treasure Island, San Francisco, California, and training in local operating and emergency procedures prior to assuming those duties and prior to designation in an NRMP. For training other than NAVTECHTRACEN Treasure Island courses, a complete course description and curriculum outline shall be submitted to NAVSEADET RASO for approval prior to individuals assuming the aforementioned duties.

3. Personnel who frequent or work in the RADIAC Calibration Laboratory shall receive at least eight hours of training on those subjects required by 10 CFR 19.12.

4. Annual refresher training shall be conducted for all personnel in accordance with Section II, Part 2 of this manual.

5.3 RADIATION SURVEYS

REQUIREMENTS:

1. A radiation survey of all accessible spaces adjacent to each calibration room shall be performed at least semiannually. All gamma and neutron calibration source(s) which could logically be exposed simultaneously shall be fully exposed during the survey. The record of survey shall contain at least the following:

a. Date of survey.

b. Sketch of the facility showing the location of survey points relative to the radiation source.

c. Source activity and date of determination.

d. Source(s) serial number(s).

- e. Exposure rate at each survey point.
- f. Radiation survey instrument type and serial number.
- g. Radiation survey instrument calibration date.
- h. Name and signature of individual performing the survey.

2. A contamination survey of all areas where contaminated instruments or sources are handled or stored shall be conducted at least daily. A record of surveys shall be maintained.

3. A complete radiation protection survey of the facility and all accessible spaces adjacent to each calibration room shall be performed by the RSO or a qualified individual after any of the following:

- a. Receipt of a new source with higher activity than the old source.
- b. Any modifications to the room which result in changes to the shielding integrity.
- c. Increase in occupancy of adjacent spaces or workload.
- d. Other action which may increase the potential for exposures outside the exposure room.

A copy of the survey report shall be forwarded to NAVSEADET RASO for approval. Approved survey reports shall be maintained as a permanent record by the calibration laboratory.

5.4 SOURCE INVENTORY, INSPECTION AND MAINTENANCE

REQUIREMENTS:

1. A physical inventory of all radioactive commodities and radioactive material authorized by a NRMP held by a calibration facility shall be conducted at least semi-annually. As a minimum, the inventory record shall be retained for three years and include the following:

- a. Complete nomenclature of each source.
- b. Serial number of each source.
- c. Isotope.
- d. Activity.
- e. Location of each source.

f. Date of inventory.

g. Name and signature of individual performing the inventory.

2. Radioactive check sources containing exempt quantities of radioactive material contained in RADIACs that are held by a laboratory for calibration or repair need not be reported on the semi-annual source inventory. These sources are accounted for separately by inventory control records generated by the stocking activity when the RADIAC is issued to the end user.

3. Daily or prior-to-use, all calibrators, interlocks, audible and visual warning devices, and all other safety devices shall be checked for proper operation. If any device does not operate, it shall be repaired prior to performing calibrations. A record of preoperational checks shall be maintained for three years.

4. Maintenance and repair of calibrators, interlocks, warning devices, and other safety related devices shall only be performed by personnel determined by the RSO to be appropriately qualified. Records of maintenance shall be maintained for three years.

5. All shields, interlocks, and other safety devices shall be inspected by personnel who are knowledgeable in their design, operation and maintenance.

5.5 RECEIPT, SURVEY AND DECONTAMINATION OF RADIACS

REQUIREMENTS:

1. Each radiation survey instrument presented to a calibration facility shall be surveyed for contamination before the instrument is accepted into the laboratory.

2. Contamination levels shall not exceed the limits in Table 4.

3. Any instrument, carrying case or component found to be contaminated during the receipt survey shall be segregated from noncontaminated items as soon as practicable. A record of all contaminated items shall be maintained. The record shall contain at least the following information:

a. Date, time of receipt and time of decontamination.

b. Nomenclature and serial number of item.

c. Command from which received.

d. Contamination level when received.

- e. Contamination level at termination of decontamination operation.
- f. Disposition of item.
- g. Name and signature of individual performing decontamination.

4. Items which cannot be decontaminated to acceptable levels shall be disposed of as low-level waste in accordance with procedures in SPAWAR Notice 9673.5F or NAVSEA SE700-AA-MAN-210/RADIAC.

5. Activities handling radiation survey instruments with accompanying check sources shall maintain a custody control log showing from whom such survey instruments are received and to whom they are transferred.

6. Notify the shipping activity that RADIACs they sent were contaminated and that a contamination survey of their operations is warranted.

5.6 PERSONNEL DOSIMETRY

REQUIREMENTS:

1. Thermoluminescent primary dosimeters shall be worn in accordance with Chapter 6, NAVMED P-5055.

2. Personnel who operate the AN/UDM-1A calibrator shall wear a self-reading pocket dosimeter (0-200 mR). Dosimeters shall be recharged at the start of each day of use and the cumulative reading recorded at the end of operations or shift. A pocket dosimeter log, containing at least the following information, shall be maintained (a sample pocket dosimeter log is attached as Appendix D):

- a. Command or activity name.
- b. Date of issue of the pocket dosimeter.
- c. Name of person issued to.
- d. Dosimeter serial number.
- e. Initial pocket dosimeter reading.
- f. Final pocket dosimeter reading.
- g. Net pocket dosimeter reading (final minus initial).

5.7 OPERATING AND EMERGENCY PROCEDURES

REQUIREMENTS:

1. Operating and emergency procedures shall be established, in writing and be command endorsed, for each calibration source, or source set. The instructions shall include, as a minimum, detailed operating procedures for each calibrator or source set utilized and detailed emergency procedures for all reasonably foreseeable emergency conditions that may be encountered.

2. Established operating and emergency procedures shall be made a part of the application for a NRMP. Any change in the operating or emergency procedures shall require an amendment to the NRMP.

3. Each calibration laboratory shall conduct at least one emergency drill annually. The drill shall be based on one or more of the emergency situations outlined in the emergency procedures and shall include participation by fire department and other emergency response personnel.

5.8 SOURCE LEAK TESTS

REQUIREMENTS :

1. Calibration sources shall be leak tested in accordance with paragraph 2.6.9 of this manual or as specified in a NRMP.

2. All RADIACs containing check sources that require leak testing, as listed in NAVSEA SE700-AA-MAN-210/RADIAC, shall be source leak tested when the instruments are presented for repair or calibration. A copy of the leak test results shall be maintained by the calibration facility for three years and included with the calibration certificate when the instrument is returned to the using activity.

3. Calibration sources and instrument check sources that fail the leak test shall be disposed of in accordance with the procedures outlined in NAVSEA SE700-AA-MAN-210/RADIAC.

SECTION VI

RADIOACTIVE MATERIALS REMOVAL PROGRAMS

6.1 PERSONNEL PROTECTION

6.1.1 ISOTOPES AND ASSOCIATED HAZARDS

DISCUSSION:

Radioactive materials have been used by the U.S. military for many years in a variety of applications. One of the more common was the use of radium-226 as the activating agent in luminescent paint used on gauges and dials in ships and aircraft. This type of paint was used extensively from World War I through the mid-1960s. Radium-226 was a poor choice of activators because the intense alpha particle bombardment damages the fluorescent component so that after a few years the item is no longer self-luminous. Moreover, radium is a very hazardous radioactive source with a long physical half-life (1,602 years). For this reason, in the early 1970s DOD formulated a policy that the procurement of radium-226 was to be discontinued unless it was demonstrated that a non-radioactive substitute or less hazardous radioactive substance could not be used. However, due to the extensive prior use, there are still items in the supply system and in active use that contain radium-226.

Additionally, there are several other radionuclides that are used rather extensively in Navy and Marine Corps equipment and commodities.

Radioactive materials removal programs are designed to safely remove and dispose of the more hazardous materials and replace them, if necessary, with less hazardous items. Table 9 lists the most commonly used radioisotopes, types of radiations from each, and common uses.

6.1.2 PERSONNEL PROTECTION EQUIPMENT

DISCUSSION:

In many radioactive material removal operations, the radioactive material is usually in a chemical form, or such a small quantity, that extensive contamination is not encountered. Rubber gloves or latex gloves will often be the only protective clothing required for removal operations. Shoe covers, coveralls, and masks or respirators should be available for use if surveys indicate extensive contamination.

Airborne contamination will seldom be encountered. However, a significant airborne contamination hazard could be encountered during initial entry into a space that has been tightly closed for a long period of time and contains a large quantity of

radium or tritium. Ventilation of spaces prior to entry will greatly reduce the possibility of significant exposure due to airborne radioactivity.

REQUIREMENTS:

1. Appropriate protective clothing, to include shoe covers, disposable coveralls, rubber gloves, and protective masks shall be available for use if surveys indicate extensive contamination.
2. Spaces containing large quantities of radium or tritium containing devices shall be ventilated prior to entry.

6.1.3 MEDICAL EXAMS AND BIOASSAYS

REQUIREMENTS:

1. All personnel performing surveys or removing radioactive material shall be medically qualified as radiation workers in accordance with NAVMED P-5055.
2. All personnel assigned duties involving the handling of radium sources shall have radon breath analyses performed in accordance with NAVMED P-5055.
3. If any individual is suspected of having received an internal deposition of any radioactive material as a direct result of his employment, the cognizant RSO shall immediately request assistance from BUMED (MED-212). NAVSEADET RASO shall be notified of the incident by telephone or priority message within 24 hours.

6.1.4 PERSONNEL MONITORING

REQUIREMENTS:

1. All personnel performing surveys, removal or packaging operations shall wear a primary dosimetric device authorized by CHBUMED. Exposure records shall be maintained in accordance with Chapter 5 of NAVMED P-5055.
2. When performing any operation where the whole body could receive 100 mrem/hour or greater, all personnel shall wear two self-reading pocket dosimeters with a range of 0-200 mrem. The dosimeter shall be recharged at the start of each shift, prior to use. Pocket dosimeters should be checked frequently during use. A log of pocket dosimeter use shall be maintained for at least two years. As a minimum, the log shall contain the date, name of individual, dosimeter serial number, initial, final and net readings. A sample pocket dosimeter log is attached as Appendix D.

6.1.5 PERSONNEL TRAINING

REQUIREMENTS:

1. Personnel performing radioactive material removal operations under the direction of Navy Inactive Fleet shall be trained in accordance with Chapter 4, Inactive Fleet Environmental and Occupational Safety Manual and the site contract.
2. Personnel performing radioactive material removal operations not under the direction of Navy Inactive Fleet shall receive at least 40 hours training in radiation safety, removal procedures, contamination control, and packaging and disposal requirements. Course curricula shall be submitted to NAVSEADET RASO for approval prior to the training. A record of the training, including course outlines, if training is performed locally, shall be maintained for at least two years.
3. All personnel assigned to duties involving radioactive material removal operations on a continuing basis shall receive at least six hours annual refresher training in radiation safety and related subjects. A record of refresher training shall be maintained for at least two years.

6.2 INACTIVE SHIPS PROGRAM

6.2.1 INTRODUCTION

DISCUSSION:

Because of their age, inactive ships and ships being transferred to inactive status are the largest single source of radioactive material requiring removal operations. While many isotopes may be present, radium is the most common.

Radioactive material removal operations on inactive ships are the responsibility of NAVSEASYS COM Navy Inactive Fleet. Radioactive material removal procedures and requirements are detailed in Chapter 4, Inactive Fleet Environmental and Occupational Safety Manual.

6.2.2 RADIACS

REQUIREMENT:

An allowance for RADIAC instruments shall be established for each Navy Inactive Ship Maintenance Facility. Procedures for establishing and modifying an allowance are contained in NAVSEASYS COM ltr Ser CEL-DS/0050 of 30 October 1986 as revised by NAVSEASYS COM ltr Ser CEL-LB/060 of 12 December 1986. Required instruments are listed in Chapter 4, Inactive Fleet Environmental and Occupational Safety Manual.

6.2.3 RADIATION LEVEL AND CONTAMINATION CRITERIA

See Section 2.6

6.2.4 REMOVAL, PACKAGING AND TRANSPORTATION

REQUIREMENT:

Sources that have been removed from inactive ships shall be packaged in accordance with the requirements of 49 CFR and Section II, Part 8 of this manual.

6.2.5 CANNIBALIZATION

REQUIREMENTS :

1. Cannibalization of any item containing radioactive material is not permitted without prior approval of NAVSEASYSKOM (SEA-07A).
2. Any item suspected of being contaminated removed from an inactive ship shall be surveyed and certified to be free of radioactive material before it is released from the Inactive Ship Maintenance Facility.

SECTION VII

RADIOACTIVE COMMODITIES WITHIN THE NAVAL SUPPLY SYSTEM

7.1 GENERAL

DISCUSSION:

This section outlines procedures and defines responsibilities at all Navy and Marine Corps activities for the control of radioactive commodities.

This section includes standard methods for handling, storage, and control of NSN-numbered items of all types that contain radioactive material except:

1. Radioactive material associated with the Navy Nuclear Propulsion Program.
2. Nuclear weapons.
3. Radionuclides used for diagnostic or treatment procedures in BUMED programs.
4. Materials used in accordance with a general materials license issued by the Nuclear Regulatory Commission (NRC).

REQUIREMENTS:

1. All personnel handling or using radioactive commodities shall ensure that exposure to ionizing radiation is kept as far below Navy radiation protection standards as practical. These personnel shall receive training commensurate with their duties and responsibilities prior to assignment to those duties.
2. The use and stocking of radioactive materials in items of supply shall be kept to a minimum consistent with service or activity needs. Practical non-radioactive substitutes shall be procured and used where feasible.
3. Radium shall not be procured or used unless it has been established that a non-radioactive substitute or a less hazardous radioactive substance cannot feasibly be used. Requests to procure or use radium shall be submitted via NAVSEADET RASO to NAVSEASYS COM (SEA-06GN). The request shall include documentation that justifies the need and verifies that a non-radioactive material or a lesser radioactive one is not available or adequate.

7.2 RESPONSIBILITIES

REQUIREMENTS:

7.2.1 COMMANDERS OF SUPPLY FACILITIES

Commanders of supply facilities shall:

1. Be responsible for and assure safe handling, storage, and shipment of radioactive materials at their facility.
2. Assure procedures are prepared for handling credible emergencies during receipt, storage, maintenance, and shipment.
3. Assure compliance with this manual, pertinent service or agency directives, conditions of pertinent NRMPs or NRC licenses, and applicable federal regulations governing the use, control and accountability of radioactive materials at their activities.
4. Be responsible for control and accountability of radioactive material at their activities.
5. For quantities greater than those listed in Table 3, assure that requiring or requisitioning activities submit a written certification that they are authorized by NRMP or NRC license to receive the type, form and quantity of radioactive material requested. The certification must specify the license or permit number, issuing agency and expiration date.
6. Appoint, in writing, individuals qualified by training and experience (per Section II, Part 2) to act as RSO and ARSO with prime functional responsibility for radiological controls.
7. Ensure that all required records and reports are maintained and submitted in a timely manner.
8. Ensure that discrepancies between published data concerning radioactive commodities and data determined by examination at the activity is reported to the appropriate supply agency or activity.
9. Assure that commodities or end items received for repair, maintenance or disposal are marked in accordance with MIL-STD-129, prior to return to stock or use.
10. Ensure that radioactive material storage areas are posted, surveyed, and monitored.
11. Ensure that written operating and emergency procedures for handling, receipt, storage, maintenance, shipment and disposal of radioactive commodities are prepared

and posted in all work areas to which they apply, and that personnel are trained in these procedures.

12. Comply with all applicable directives for the disposal of excess, surplus, and condemned radioactive commodities and of radioactive waste.

7.2.2 RADIATION SAFETY OFFICERS

Activity RSOs shall:

1. Conduct complete radiation surveys of sufficient scope to evaluate specific potential hazards associated with all areas where sources of ionizing radiation are used or stored.

2. Be responsible for overall supervision and management of the radiation controls program.

3. Assure compliance with pertinent general radiological control provisions and procedures of Section 2.6.

4. Ensure that waste or surplus materials containing radioactivity are disposed of at least annually.

5. Ensure that all occupationally exposed personnel assigned to duties which require work directly with sources of ionizing radiation and have a potential for exposure are given a radiation medical examination in accordance with NAVMED P-5055.

6. Act as activity liaison with appropriate Medical Department representatives to ensure that dosimetry requirements for personnel monitoring and reporting are met.

7. Provide technical input in the development and promulgation of standard and emergency operating procedures for all areas where sources of ionizing radiation are used or stored.

8. Ensure that all such procedures are posted in the work areas to which they apply and that personnel are trained in these procedures.

7.3 COMMODITIES CONTAINING RADIOACTIVE MATERIAL

DISCUSSION:

Radioactive material is strictly defined as any material or combination of materials which spontaneously emits ionizing radiation.

A radioactive commodity is an item of government property, containing radioactivity equal to or in excess of the quantities listed in 10 CFR 20, Appendix C or contains a specific activity greater than 0.002 microcuries per gram of radioactive material and to which a National Stock Number (NSN) has been assigned. Table 10 cites examples of these commodities.

Generally there are five types of NSN-numbered commodities containing radioactivity stocked in the supply system: electronic devices (including electron tubes), luminescent (self-illuminating) devices, ionization devices, commodities containing natural sources, and analytical devices.

REQUIREMENTS:

1. Materials shall be controlled as radioactive if:
 - a. The item is marked as radioactive or labeled with the three bladed (trefoil) radiation symbol or;
 - b. The item is coded as radioactive ("R") in the Hazardous Materials Information System (DoD 6050.5LR or DoD 6050.5L microfiche); DoD MIL-HDB-600; Identification of Radioactive Items in the Army Supply System (TB 43-0116); or other promulgated federal, agency, service, or RASP directives.
2. In addition, items shall be handled as radioactive material if any of the following conditions exist:
 - a. One-tenth of one millirem per hour above background when measured by an open-window beta-gamma survey meter (AN/PDR-27, IM-231 or an instrument of equivalent sensitivity) held within one inch of the item.
 - b. One hundred counts per minute above background as measured with an IM-247APD/DT-304 (or an instrument of equivalent sensitivity) held within one-half inch of the item.
 - c. Loose surface contamination measured on a dry swipe wiped over 100 square centimeters of the surface of the item, or over the total surface area if less than 100 square centimeters, exceeds the limits in Table 4 of this manual.

d. Alpha radiation is detectable using an AN/PDR-56 alpha survey meter or instrument of equivalent sensitivity, by direct measurement on the material, or on a dry swipe wiped over 100 square centimeters of the surface of the item, or over the total surface area if less than 100 square centimeters.

7.4 PROTECTION OF PERSONNEL HANDLING RADIOACTIVE COMMODITIES

DISCUSSION:

Responsibility for minimizing radiation exposure and controlling radioactive materials is shared by unit commanders, RSOs, supervisors and individual radiation workers. This responsibility includes orientation and indoctrination of personnel who are subject to occupational exposure to ionizing radiation; promulgation and implementation of applicable directives and standard operating procedures; provision for personnel dosimetry, medical examinations, RADIAC instrumentation, and specialized equipment when required; and the fostering of a work environment that encourages an emphasis on maintaining occupational radiation exposure ALARA.

REQUIREMENTS:

1. All radiation workers and limited radiation workers shall be trained and records maintained as required by Section II, Part 2 of this manual.
2. Control procedures shall be developed for the protection of personnel handling radioactive commodities (e.g., shipment, inspection, storage, use, maintenance and disposal operations).
3. All activities whose personnel handle radioactive commodities shall prepare standard operating procedures. These procedures shall be tailored to the operation being performed and the type of commodities handled.
4. Personnel exposure to ionizing radiation shall be maintained ALARA and shall conform to the requirements of Section II, Part 1 of this manual.
5. Removable loose radioactive contamination in all areas shall not exceed the limits in Table 4.
6. Written standard operating procedures which specify measures to minimize internal hazards from such operations as handling leaking sources, repairing broken radioactive commodities, working in contaminated areas or in airtight storage areas containing leaking gaseous sources, and accident response shall be prepared.
7. Smoking, eating, drinking, and chewing shall be prohibited in areas where radioactive materials are stored or handled.

8. Storage of food, beverages, tobacco products and materials, cosmetics, and eating and drinking utensils shall be prohibited in areas where radioactive materials are stored or handled.

7.5 RADIOLOGICAL CONTROLS PRACTICES AND PROCEDURES

DISCUSSION:

This section provides general guidelines which shall be included in standard operating procedures applicable to use, storage, maintenance, and disposal of radioactive commodities. These procedures shall be developed in coordination with designated radiation protection personnel and tailored to the operation being performed and the type and number of commodities handled.

7.5.1 ADMINISTRATIVE CONTROLS

REQUIREMENTS:

All activities storing, stocking or performing maintenance on radioactive commodities shall develop administrative controls to:

1. Assure safe handling, storage and shipment of radioactive commodities.
2. Assure safe operation of repair and maintenance facilities handling radioactive components, where applicable.
3. Assure procedures are prepared for handling credible emergencies during receipt, storage, maintenance, and shipment.
4. Report defective radioactive commodities to the Material Inventory Control Point.
5. Comply with all applicable directives for the disposal of excess, surplus and condemned radioactive commodities and or radioactive waste.
6. Conduct a physical inventory of all radioactive commodities at least annually.
7. In conjunction with each physical inventory, ensure an audit of the general radioactive material accountability system shall be conducted by a person other than the custodian. This audit shall include a comparison of the results of the previous inventory, after deletion of all items transferred or shipped from the organization and addition of all items received by the organization, with the current inventory results. This audit shall also include a visual search for marked radioactive material that is not accounted for. The audit report shall state the results of the comparison and search. Discrepancies shall be reported in writing to the Commanding Officer. All discrepancies shall be

investigated and resolved. Complete audit reports together with reports of any corrective action taken shall be retained for three years or until the next inspection from NAVSEADET RASO, whichever is longer.

8. The supply and, where appropriate, the stocking activity shall establish a computer inventory program for radioactive commodities. The program shall be able to print out all radioactive commodities in storage by NSN, hazard code, and name, and if available, quantity, radioisotope, activity, location, and status. The RSO shall be able to obtain this printout upon request and distribute to emergency support elements as required.

9. All losses of radioactive materials shall be reported in accordance with instructions (in control literature for that commodity), and as required by Navy directives.

10. All radioactive commodities shall be marked with a label or sign containing the three-bladed radiation symbol and the words, "Caution - Radioactive Material", along with the isotope and activity if known. MIL-STD 129 (Military Standard Marking for Shipment and Storage) applies.

7.5.2 STORAGE AREAS

1. All storage areas containing radioactive materials, and entrances to such areas, shall be labeled with signs containing the three-bladed radiation symbol and the words "Caution - Radioactive Materials". Signs, either permanent or temporary, shall be securely fixed to barriers, walls, doors, fences, or ropes.

2. Areas used for storage of radioactive commodities shall be kept to the minimum for adequate control.

3. Radioactive commodities shall not be stored in the same warehouse section with explosives, flammable materials, photosensitive items (e.g., photographic film), food products or other incompatible commodities.

4. Radioactive materials shall be stored so that they are protected from adverse weather or conditions which may deteriorate the packaging materials.

5. Commodities that contain radioactive gases, tritium containing devices, or radium shall be stored in ventilated structures.

7.5.3 FIRE PROTECTION PRACTICES

REQUIREMENTS:

Proper selection of a fire resistant storage area for radioactive material will minimize release of radioactivity to the environment in event of a fire. The following considerations and practices shall be observed when selecting storage areas for radioactive material.

1. Whenever feasible, radioactive materials shall be stored in fire resistant containers to minimize contamination spread.
2. Smoking, eating, drinking, and chewing shall NOT be permitted in radioactive material storage areas.
3. A current list of locations where radioactive materials are stored shall be available to personnel who might be called to fight a fire in such areas. This list should also identify unusual problems.
4. Semi-annual inspection of radioactive material storage areas shall be made to identify fire hazards by personnel trained in fire protection procedures. Deficiencies shall be promptly corrected.

7.5.4 CONTAMINATION CONTROL

DISCUSSION:

Contaminated items are often stored in plastic bags which may break. Liquid, inadvertently left in a container may leak out, and condensation of moisture from the atmosphere may drip on exposed, contaminated surfaces. Unless all contaminated surfaces of stored materials are appropriately wrapped or contained to prevent the spread of contamination, the entire storage location shall be considered potentially contaminated. When all contaminated surfaces are appropriately wrapped, personnel may walk through these areas without anti-contamination clothing.

REQUIREMENTS :

1. Personnel in potentially contaminated storage areas, particularly if they handle contaminated materials, shall wear necessary anti-contamination clothing.
2. Reasonable care shall be taken in packaging and storing contaminated items to prevent the spread of contamination and to ensure that entry to areas where such storage is permitted does not result in the contamination of personnel or other areas.

7.5.5 STORAGE OF CALIBRATION AND TEST SOURCES

DISCUSSION:

Radioactive materials, particularly calibration and test sources, which contain more than one millicurie of radioactivity and can be easily stolen or mishandled because of their small size, require special precautions.

REQUIREMENTS:

1. Small radioactive sources containing more than one millicurie of activity shall be stored in locked areas or cabinets, access to which is limited to authorized individuals.

2. Small RADIAC calibration or test sources shall be attached to encumbering devices, such as large rings, mounting boards or storage boxes to the extent practical so as not to interfere with normal use of the source. Encumbering devices are not required for sources in planchet provided for use with counter-scalers.

7.5.6 RADIATION SURVEYS

REQUIREMENTS:

1. Surveys of all areas where quantities of radioactive materials in excess to those listed in Table 3 are used or stored shall be performed at least every six months, and records maintained for three years.

2. Radiation protection surveys shall document:

a. Location and extent of any radioactive contamination and radiation levels, appropriateness of boundaries, signs, markings, and protective equipment and procedures.

b. Corrective action(s) taken to correct observed deficiencies.

c. Date of survey, model, serial number, and date of calibration of RADIAC instrument, and name and signature of surveyor.

3. Results of surveys shall be reported to operating supervisors with recommendations for corrective actions as necessary.

4. Closeout radiation surveys shall be made and documented for all storage and maintenance locations when operations involving radioactive commodities have terminated. Limits of Table 4 of this manual shall be met. Surveys shall be forwarded to NAVSEADET RASO for review and approval, and shall be kept on file indefinitely.

7.5.7 SURPLUS RADIOACTIVE COMMODITIES

REQUIREMENTS:

1. Surplus radioactive commodities shall NOT be transferred to the Defense Reutilization and Marketing Office (DRMO), but shall be retained until shipping instructions are received from the Inventory Control Point.
2. Items which cannot be decontaminated or repaired shall be disposed of by the service or agency as radioactive waste.
3. Surplus items containing radioactive material shall be disposed of as radioactive waste when the Inventory Control Point or owning activity determines that any other method of disposal is not in the best interest of the government.
4. All radioactive waste shall be disposed of in accordance with Section VI of this manual, NAVSUPINST 5101.9B, 10 CFR 20, and burial site criteria as applicable. Under no circumstances shall material marked as "radioactive" be disposed of as uncontrolled refuse for incineration or burial in unrestricted landfills. Disposal of radioactive waste by burial on Navy property or at sea is not authorized. In accordance with 10 CFR 30.15, certain products containing less than specified quantities of several listed radionuclides are exempt from the requirements of 10 CFR 20 and 10 CFR 30 through 35. Products qualifying as exempt under 10 CFR 30.15 may be disposed of with normal solid wastes provided radioactive material warning labels, if any, are removed and subject to specific quantity limits specified in 10 CFR 30.15.

7.6 TRANSSHIPMENT OF NRC LICENSED RADIOACTIVE MATERIAL

DISCUSSION:

Supply activities serve as transshipment points for NRC licensed radioactive material. They receive, store incident to transportation, and transfer radioactive material to firms authorized by a NRC or a state license or to a naval command authorized by a NRMP. Radioactive materials in this category are generally larger in quantity (a millicurie or more) and often small in physical size. These properties require additional controls to prevent unauthorized use or loss and inadvertent personnel injury. Gamma radiography sources routinely used by the Navy have quantities up to 100 curies and can cause serious injuries and death if mishandled. Strict adherence to established procedures are an absolute necessity during the movement and temporary storage of these sources within the Navy supply system.

7.6.1 RECEIPT

REQUIREMENTS:

1. To the maximum extent possible, all material shall be received in a single location.
2. Only designated and qualified personnel shall receive or handle the material.
3. Supply activities that expect to receive packages containing more than Type A quantities as listed in Table 6 shall make arrangements:
 - a. To receive a package when it is offered for delivery by the carrier; or
 - b. To be notified by the carrier when a package arrives at the carrier's terminal and to pick up the package as soon as possible after notification.
4. All packages containing radioactive material shall be surveyed as soon as possible after being located in an incoming shipment. When the package shows signs of damage (crushed, wet, or visible damage), the vehicle shall be monitored for contamination. The vehicle shall not be released until contamination is reduced to the level specified in 49 CFR 173.443.
5. Shipments shall be examined to determine if there is any leakage from contents or apparent damage. If damage or leakage is suspected, the RSO shall be notified immediately and the package shall not be moved or further handled except as directed by the RSO.
6. Shipping documents shall be reviewed to insure that they are properly prepared in accordance with Navy, NRC and Department of Transportation (DOT) requirements.
7. Packages containing NRC licensed radioactive material shall not be opened unless directed by the RSO as a result of package damage or discrepancy.

7.6.2 RECEIPT SURVEYS

REQUIREMENTS:

1. Each package labeled as containing radioactive material and not exempt as specified below shall be monitored for removable external surface contamination within three hours if received during working hours or within 18 hours if received after normal working hours.
 - a. The following packages are exempt from surface contamination monitoring:
 - (1) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125.

(2) Packages containing only radioactive material as gases or in special form.

(3) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit.

(4) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

b. If removable radioactive contamination exceeds 0.01 microcuries per 100 square centimeters of package surface, notify the RSO immediately. See Article 2.10 for reporting requirements (10 CFR 20.205).

2. Each package of radioactive material containing more than Type A quantities (except for packages in exclusive use vehicles) shall be monitored for radiation levels at the surface and three feet (one meter) from the package. The monitoring shall be conducted within three hours if received during normal working hours or within 18 hours if received after normal working hours. If the radiation level exceeds 200 mR/hour at the surface or 10 mR/hour at three feet, notify the RSO immediately. See paragraph 2.10 for reporting requirements.

7.6.3 STORAGE

REQUIREMENTS:

1. Radioactive materials shall be stored in locked areas with the number of keys and the individuals with access to the keys kept to a minimum.

2. Radioactive material shall not be stored in the same warehouse section with explosives, flammable materials, photosensitive items (e.g., photographic film), food products, or other incompatible commodities.

3. Caution Radioactive Material signs shall be posted at the entrances to each storage area.

4. Boundaries of the storage area shall be surveyed and checked whenever new packages are received to determine proper warning signs. Radiation levels at the boundary shall not exceed 0.5 mrem/hour.

5. Caution Radiation Area and Caution High Radiation Area signs shall be placed, when applicable, at each entrance and other locations surrounding such areas.

7.6.4 SHIPMENT

REQUIREMENTS:

1. The supply activity shall verify consignee authorization to receive the radioactive material. This is an NRC or state license for commercial firms or a NRMP for Navy commands as required by 10 CFR 30.41.

2. Before shipment, the packages shall be inspected for damage, leakage, and radiation level and for proper classification, marking, labeling, shipping papers and certification.

3. The supply activity shall formally notify the consignee or transportation officer by priority message or equivalent method at least 24 hours prior to the expected arrival of the package at the consignee.

7.6.5 GAMMA RADIOGRAPHY ADDITIONAL PRECAUTIONS

REQUIREMENTS:

1. Gamma radiography source packages (source changers or exposure devices) shall be transferred without delay per applicable routing instructions.

2. When gamma radiography source packages are received without shipping papers or routing instructions, the RSO shall be notified and SPCC shall be contacted to obtain proper routing instructions.

NOTE:

MOST GAMMA RADIOGRAPHY SOURCES
CONTAIN IRIIDIUM-192 IN SPECIAL FORM.
SOME CONTAIN COBALT-60. THE TYPE A
QUANTITY LIMIT FOR IRIIDIUM-192 IS 20
CURIES. THE TYPE A QUANTITY LIMIT FOR
COBALT-60 IS 7 CURIES.

3. Gamma radiography sources shall not be left unattended on loading docks or released to unauthorized personnel.

7.7 EMERGENCY ACTIONS AND PROCEDURES

REQUIREMENTS:

1. The primary objective of emergency action shall be the protection of personnel from hazards to life and limb as during a fire or when high-level radiation sources are

present and the secondary consideration should be the confinement of the contamination to the local area of the incident. If there is reason to believe that personnel may have been contaminated or overexposed, such persons shall be moved to an area where any necessary decontamination and medical assistance can be furnished.

2. Prior plans shall be made in anticipation of radiological emergencies, in order to minimize exposure of personnel and spread of contamination. Such plans shall be written, coordinated, and rehearsed with all support organizations (fire, police, medical, maintenance, repair, damage control, and public information personnel) and transport carriers or ships to which the material is being tendered for transport. Particular procedures in the plan for any supply and maintenance activity shall depend upon the quantity and type of radioactive commodities that are stocked. Such applicable procedures that are adopted shall be written and distributed to support organizations listed above, supervisors, and foremen.

3. Fire among or near radioactive commodities might produce airborne radioactivity. The smoke from such fires should be avoided by personnel, unless they wear complete anti-contamination clothing and protective respiratory equipment. The following shall be incorporated in emergency plans and training protocols.

a. Firefighting operations might disperse radioactive materials to areas which initially were not part of the incident site. The draining of liquids from firefighting operations shall be properly managed and, when necessary avoided by personnel.

b. A perimeter cordon or controlled entry shall be formed as soon as possible to prevent access of unauthorized personnel. Size of perimeter cordon or method of controlled entry shall be dependent upon the radiological or other health hazard associated with the radiological emergency. All personnel leaving the area shall be monitored and decontaminated if necessary. No smoking, eating, chewing or drinking shall be permitted within the perimeter.

4. When personnel are seriously injured, all other considerations (except fire, explosion, atmosphere immediately dangerous to life) shall become secondary until urgent first aid is given, help for rescue (if necessary) is summoned and evacuation is completed. Unless there is a high risk to life or limb, injured or unconscious individuals shall not be moved until directed by medical, para-medical, or professional rescue personnel.

5. As soon as the immediate emergency is under control, a detailed radiological survey shall be conducted of the affected area(s). Provided that the spread of contamination has been halted, priorities can be assigned to decontamination parties working in contaminated areas. Those areas requiring control of exposure time shall be controlled by an individual trained in radiological safety. Assistance from outside source(s) shall be requested as needed.

6. The following emergency procedures shall be incorporated into written emergency operating procedures. Emergencies will generally be in the nature of spills, fires, or explosions which could cause release and dispersal of radioactive material over surfaces, in the air, soil, or water. In case of emergency, the following procedures shall be followed:

a. Attempt to extinguish fire if present and a significant radiation hazard (i.e., due to the presence of high level radiation sources whose shielding has been compromised) is not immediately apparent.

b. Stop the spill and evaluate for external radiation or contamination levels.

c. Warn all persons in the area of the emergency and evacuate the area immediately.

d. Isolate the area of the spill with cordons or physical barriers.

e. Minimize the spread of contamination and exposure of personnel to radiation and contamination.

f. Notify the fire, police, and medical personnel, if appropriate, indicating involvement of radioactive material.

g. Shut off ventilation, heating and air conditioning equipment if airborne contamination is present to prevent the spread of contamination.

h. Notify the RSO and immediate supervisor.

i. Monitor all persons involved in the emergency or control action.

j. Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination. The RSO shall be available for this determination.

k. Notify NAVSEADET RASO of the occurrence.

7. Emergency telephone numbers shall be conspicuously posted near telephones in the workplace to which they apply.

BLANK

SECTION VIII

TYPE A PERMITS OF BROAD SCOPE

8.1 TYPE A BROAD SCOPE PERMIT CONDITIONS

DISCUSSION:

Type A Permits of Broad Scope differ from all other types of radioactive materials permits in that they allow much latitude in choice of quantities and types of radioactive sources, and because they are based primarily on administrative procedures and organizational qualifications of the command to operate safely rather than on a detailed review of the qualifications, equipment and procedures of the user and detailed limitations established by a NRMP.

REQUIREMENTS:

1. Radioactive material shall only be used by, or under the direct supervision of, individuals approved by the Command Radiation Safety Committee.
2. The command shall establish a comprehensive radiation safety program which incorporates the requirements of this section and other applicable requirements of this manual.
3. In accordance with 10 CFR 33.17(a), a Type A permit does not authorize the following:
 - a. Tracer studies in the environment involving direct release of radioactive material.
 - b. Receipt, possession, use, transfer or import of 100,000 curies or more in gamma irradiate devices.
 - c. Conducting activities requiring a specific NRMP pursuant to 10 CFR 32, 34 or 35.
 - d. Adding radioactive material to any food, beverage, cosmetic, drug, or other product designed for application to or consumption by a human being.

8.2 ORGANIZATION

DISCUSSION:

The Radiation Safety Committee (RSC) and the RSO and his staff are key individuals in administering the radiation safety program for a Type A permit of broad scope.

The RSO should have an academic degree in physical or biological science, and considerable professional experience (about five years) with radioactive materials. The administrative member, or members, should ensure management support of the radioactive materials program and due consideration of the legal interests of the organization. Technical members should have training and experience in the use of radioactive materials and radiation safety, but not necessarily as experienced as the RSO.

REQUIREMENTS:

1. The RSC shall include the RSO, at least one representative of management, and individuals qualified by training and experience from departments using ionizing radiation sources.
2. The RSC shall:
 - a. Review and approve, in advance of procurement, proposed uses of sources of ionizing radiation.
 - b. Advise on all radiological safety.
 - c. Review radiological incidents.
 - d. Delegate authority to approve procurement, transfer, or disposal of radiation sources which are defined as routine.
 - e. Qualify individuals as authorized users.
3. The RSC shall meet at least quarterly.
4. The RSC shall meet to act on unresolved or new safety issues, non-routine requests, or uses which require extra command or departmental coordination or cooperation.
5. A quorum of the RSC consisting of the RSO, acting as chairman, and two members qualified by training and experience shall conduct routine RSC business such as approving or disapproving routine procurements or to qualify users.
6. A written record of all committee actions shall be maintained. Records of routine RSC business shall be reported to the full committee at least quarterly.
7. The RSC shall conduct a full review of the radiation safety program annually.
8. The RSO shall be responsible for the day-to-day coordination and management of the radiation safety program.
9. The RSO shall report to the Commanding Officer in a staff capacity and shall brief the CO on the entire radiation safety program at least semi-annually.

10. The RSO shall have ready access to all levels of the command organization with the authority to immediately terminate a project if found to be a threat to health, safety or property and shall report all radiological incidents to the Commanding Officer.

11. The RSO shall be a full-time assignment supported by a staff commensurate with the program size and complexity.

12. RSO duties shall include:

a. Maintaining NRMPs and preparing permit applications, amendments, renewals, and reports as required by federal and Navy directives.

b. Establishing basic guidelines and advising supervisors and employees in radiological protection.

c. Coordinating safety evaluations of all proposed uses of radioactive material.

d. Maintaining routine surveillance and monitoring records of all restricted areas.

e. Determining compliance with rules and regulations, permit conditions, and the conditions of project approvals specified by the RSC.

f. Receiving, opening, and delivering all shipments of radioactive material arriving, and receiving, packaging, and shipping all radioactive material leaving the command.

g. Maintaining an inventory of all radiation sources.

h. Supervising and coordinating the radioactive waste disposal program including maintaining waste storage and disposal records and monitoring effluents.

i. Storing all radioactive materials not in current use, including wastes.

j. Distributing personnel monitoring devices and arranging for their processing, determining the need for bioassays, keeping records of personnel exposures and bioassays, notifying individuals and their supervisors of exposures that are approaching maximum permissible amounts, and recommending and supervising appropriate remedial action.

k. Performing or arranging for calibration of instruments.

l. Performing leak tests on sealed sources and maintaining records of leak tests.

m. Conducting training programs and otherwise instructing personnel in the proper procedures before they are allowed to use radioactive material and as required by changes in procedures, equipment, regulations, etc.

13. Supervisors shall be responsible:

- a. To assure that all radiological operations under their supervision are properly approved in advance.
- b. For enforcing the proper use of protective clothing and equipment.
- c. For notifying the RSO promptly in every case of an accident or incident involving ionizing radiation sources.

14. Individuals shall:

- a. Know and observe regulations and procedures.
- b. Wear prescribed protective equipment and dosimetric devices.
- c. Immediately report all hazardous conditions, radiation accidents, and suspected radiation overexposures to his supervisor and the RSO.

8.3 SAFETY EVALUATIONS FOR USE OF RADIATION SOURCES

DISCUSSION:

10 CFR 33.13(3) requires safety evaluations by the RSC as a key element of administrative control necessary to obtain and administer a Type A Broad Scope Permit. In addition to radioactive material, safety evaluations will also be conducted for machine sources of ionizing radiation and naturally occurring and accelerator produced radioisotopes.

REQUIREMENTS:

- 1. Safety evaluations shall be conducted for all nonexempt sources of ionizing radiation.
- 2. Safety evaluations shall be written and include:
 - a. Training and experience requirements for project supervisors, and individual users who will use material without direct supervision.
 - b. Facilities and equipment, to include the following as appropriate:
 - (1) Shielding.
 - (2) Containment (hoods, filters, glove boxes).
 - (3) Contamination controls.
 - (4) Restricted area controls and posting.

- (5) Protective clothing.
 - (6) Survey and monitoring instruments.
 - c. Use protocols.
 - d. Operating and emergency procedures for radiological control.
3. Operating and emergency procedures shall be established for all uses of radioactive material containing radioactivity in excess of quantities listed in Table 3.
4. Operating and emergency procedures shall be established and tested prior to procurement or use of radiation sources.
5. All safety evaluations shall be maintained for the duration of the permit, including formal review and approval or disapproval by the RSO or RSC.

8.4 ADMINISTRATIVE CONTROLS

DISCUSSION:

10 CFR 33.13(3) requires appropriate procedures to control the procurement and use of radioactive material. The requirements of this part are in addition to the radiological controls in this manual.

REQUIREMENTS:

1. The RSC shall be notified in advance, in writing, of the procurement of all radiation sources (ionizing radiation producing machines, NRC licensable or accelerator produced radioactive material) and the medical (physical) qualifications, training and experience of proposed users.
2. Individuals who request approval as authorized users shall:
 - a. Be qualified by training and experience.
 - b. Successfully complete any required medical examinations.
 - c. Be certified by the branch head and division superintendent as qualified.
3. Qualification as an authorized user does not imply blanket approval to use other radiation sources.
4. Each source shall be assigned to a custodian and be assigned by source number and location. The custodian shall be an authorized user who has accepted additional responsibility for his branch or division to account for assigned radiation sources.
5. The custodian shall perform periodic inventories, keep records of inventories and assure only authorized users have access to the sources. He is responsible for knowing the location of all sources and shall be held accountable for loss.

6. Transfer of custodianship of any source shall be approved by the RSC.
7. All custodians shall inventory and transfer sources to a designated replacement custodian prior to terminating employment at the command.
8. The supply division or persons receiving radioactive material shall notify the RSO as soon as possible after receipt.
9. Sources not in use shall be stored in a locked source storage facility controlled by the RSO.
10. Personnel planning to work after normal working hours with sources of ionizing radiation shall request an evaluation and approval by the RSO prior to commencing work.
11. Emergency procedures shall be established and posted in all restricted areas. The emergency procedures shall identify:
 - a. Initial response to likely emergencies such as fire, spills, release or loss of material, or personnel contamination.
 - b. Securing the area.
 - c. Notifications and requests for assistance.
12. A security plan for radioactive material shall be:
 - a. Established.
 - b. Reviewed and updated annually.
 - c. Distributed to the Commanding Officer, RSC members, RSO, department heads, supervisors, and custodians of radiation sources.

SECTION IX

OTHER MACHINES PRODUCING IONIZING RADIATION

9.1 ELECTRON ACCELERATORS

DISCUSSION:

Accelerators vary in energy from two million electron volts (MeV) to 150 MeV and can deliver a lethal dose of radiation in as little as five seconds in the direct radiation beam. At energies above 10 MeV, they can produce neutron radiation which requires specialized survey and personnel monitoring equipment. Furthermore, the radioactive material produced by "activation" of components in or near the direct radiation beam should be controlled.

The requirements of this article are basic to operation of electron accelerators but do not substitute for a detailed analysis of operations and hazards for the specific accelerator.

9.1.1 RADIATION SAFETY REQUIREMENTS FOR ELECTRON ACCELERATORS

REQUIREMENTS:

1. Written operating and emergency procedures for radiation safety shall be established. They shall be approved by the Commanding Officer or his designated representative and reviewed annually by the RSO, accelerator operator(s), supervisors and management.
2. The accelerator operator shall be responsible for all operations of the accelerator, including the radiation safety of everyone in and around the accelerator facility. This responsibility is in addition to that of the RSO.

9.1.2 AREA CONTROLS

REQUIREMENTS:

1. Radiation levels in unrestricted areas shall not exceed two mrem/hour instantaneous exposure rate. Short duration exposures less than one hour with administrative control shall not be used to meet the unrestricted area limit of two mrem in any one hour stated in Chapter 4 of NAVMED P-5055. Exceptions to this restriction require the written approval of the RSO and NAVSEADET RASO. Requests for exceptions must include a detailed analysis which demonstrates conclusively that sufficient safeguards exist to ensure that the unrestricted areas involved are not occupied during such short duration exposures.

2. All restricted areas shall be controlled by positive means such as a wall or fence.

9.1.3 ELECTRON ACCELERATOR CONTROLS AND INTERLOCK SYSTEMS

REQUIREMENTS:

1. Instrumentation and controls on the control console shall be clearly identified and easily discernible.
2. Primary controls governing the operation of accelerators should be capable of being locked. When an accelerator is in operation, the operator in charge shall have immediate responsibility for accelerator related safety and shall have custody of keys governing accelerator operation.
3. Each entrance into an exposure room or other high radiation areas shall be equipped with a barrier and an interlock that shuts down the machine when opened.
4. Each interlock shall be on a circuit which is independent of all other interlocks.
5. All interlocks shall be designed so that any defect or component failure in its system prevents operation of the accelerator.
6. When an interlock has been tripped, it shall only be possible to restart the accelerator by manually resetting controls first at the position of the trip and last at the main control console.
7. Interlocks and access controls shall not prevent an individual from leaving a high radiation area.
8. Operation of the accelerator shall not be possible unless all interlocks are closed.
9. All emergency power cutoff switches shall include a manual reset at the site where it was activated. The function of all switches shall be clearly marked.

9.1.4 WARNING DEVICES AND AREA RADIATION MONITORS

REQUIREMENTS:

1. Each location designated as a high radiation area and each entrance to that location shall be equipped with easily observable warning lights (flashing or rotating) that operate when, and only when, radiation is being produced. The light shall be provided with a label which indicates their purpose.
2. Each accessible high radiation area shall have an audible warning device which activates for at least 20 seconds prior to the possible creation of the high radiation area. In large facilities, the audible warning device shall be on long enough that a person can

identify the signal and exit the high radiation area or reach an emergency cut off switch. This warning device shall be clearly discernible from ambient noise and from other audible signals.

3. Lights of a different color than the high radiation area warning lights shall be used for other visual indicators when they are required.

4. All access barriers and pathways leading to high radiation areas shall be posted as "Caution – Entering High Radiation Area".

5. During operation of the accelerator, radiation levels in all high radiation areas shall be continuously remotely monitored. The monitoring devices shall be electrically separate from the accelerator control and safety interlock systems and provide a readout at the control panel.

6. All area monitors shall be calibrated at intervals not to exceed three years and after each servicing and repair.

9.1.5 OPERATIONS

REQUIREMENTS:

1. Electron accelerators shall be secured to prevent unauthorized use when not in operation.

2. The interlock system shall not be used to turn off the accelerator beam except in an emergency.

3. All safety and warning devices, including interlocks, shall be examined and tested by a qualified individual for proper operation at intervals not to exceed six months. Records of such tests and maintenance shall be maintained at the accelerator facility for inspection by NAVSEADET RASO.

4. Safety and warning devices, including interlocks, shall be checked for proper operation by the operator prior to each day of use and results recorded and initialed in the operator log.

5. Current electrical circuit diagrams of the accelerator and the associated safety interlock systems shall be maintained for inspection by NAVSEADET RASO and shall be available to the operator at each accelerator facility.

6. If it is necessary to intentionally bypass a safety interlock such action shall be:

a. Authorized, in writing, by the RSO and the shift supervisor (operator).

b. Recorded in a permanent log and a notice posted at the accelerator control console.

c. Terminated as soon as possible and before resumption of routine operation.

7. A copy of the current operating and emergency procedures shall be maintained at the accelerator control panel.

8. Prior to startup, the operator shall make a personal, complete visual inspection of all high radiation areas and restricted areas, to assure all personnel have left the area.

9.1.6 RADIATION SURVEY INSTRUMENTS

REQUIREMENTS:

1. Operable and calibrated, portable ion chamber RADIAC instruments shall be available at each electron accelerator facility. The RADIAC instruments shall be calibrated for radiations being produced by the accelerator and shall be radio-frequency shielded.

2. Geiger-Mueller survey instruments shall not be used to survey the accelerator or auxiliary equipment.

3. Electron accelerators operating at energy levels greater than 10 MeV shall have neutron survey instruments available.

4. Survey instruments shall be calibrated at least every six months and after each repair or servicing.

5. Survey instruments shall be checked for proper response to radiation prior to the first use of the day or shift and after suspected damage such as dropping.

9.1.7 PERSONNEL DOSIMETRY

REQUIREMENTS:

1. Personnel dosimeters shall be used per Chapter 6, NAVMED P-5055. To provide greater reliability in evaluation of suspect conditions due to off-scale pocket dosimeter readings, two pocket dosimeters shall be worn in addition to the TLD. During operational emergencies, the RSO may authorize the use of one pocket dosimeter per person.

2. Pocket dosimeters shall be zeroed at the start of each shift during which personnel will actually conduct accelerator operations. Absolute zero need not be attained. However, it should be adjustable to read less than 10 mR. If it cannot be brought to read less than 10 mR, attempt to rezero it on another charger. If it still does not read less than 10 mR, it shall be rejected and returned to a calibration facility for evaluation.

3. Pocket dosimeters shall be read often during the shift. The initial, final and net readings for pocket dosimeters shall be recorded in a pocket dosimeter log. A sample pocket dosimeter log is attached as Appendix D.

4. Pocket dosimeters determined to go off-scale or drift prior to the first actual x-ray production of the day or shift shall be considered defective and shall not be treated as offscale pocket dosimeters. They shall be withdrawn from use and turned in to the servicing calibration facility for evaluation.

5. Pocket dosimeters found to be off-scale during or after operations require immediate action to evaluate and minimize possible personnel exposure.

6. The following procedure shall be used for evaluation of off-scale pocket dosimeter readings when two pocket dosimeters are used.

a. If only one pocket dosimeter goes off-scale, the individual shall immediately be removed from radiation work. The primary dosimetric device shall be immediately returned to the Naval Dosimetry Center for evaluation. The Dosimetry Center shall be contacted by telephone or naval message to ensure proper routing is achieved. The individual may be allowed to return to work before the results of the primary dosimetric evaluation are known if ALL of the following conditions are met:

(1) The RSO can clearly establish that the off-scale pocket dosimeter is defective (See paragraph 9.1.7.6.b. below).

AND

(2) The pocket dosimeter which was not off-scale is functioning properly (see paragraph 9.1.7.6.b. below) and reads less than 10 mR.

AND

(3) The RSO has determined that the individual was not exposed beyond the permissible limits in NAVMED P-5055 or established administrative limits.

b. The following checks shall be performed on both pocket dosimeters (NOTE: Facilities with a RADIAC Calibration Laboratory shall perform a response check using NAVSEASYS COM (SEA-04R) procedures):

(1) DRIFT CHECK. Charge to zero, then observe after two hours. Within the context of this procedure, a defective pocket dosimeter is one that undergoes greater than one-fourth of full scale deflection (upward drift) within two hours.

(2) RESPONSE CHECK. If the pocket dosimeter passes the drift check then a response check shall be performed as follows:

(a) Ensure that the pocket dosimeter has a current calibration sticker attached (NOTE: Re-calibrations are required every six months).

(b) Zero the pocket dosimeter to be checked.

(c) Tape the side of the sensitive end of the pocket dosimeter to a cesium-137 check source such as those used for the radiography survey meters.

(d) After two hours, read the pocket dosimeter.

(e) Any upscale reading indicates a positive response and the dosimeter is considered good.

(f) If no upscale reading is noted, the pocket dosimeter shall be considered defective.

c. If both pocket dosimeters go off-scale or if only one goes off-scale and the other indicates a radiation exposure of greater than 10 mR, the individual shall not be permitted to return to radiation work until the results of the primary dosimetric device evaluation are known.

9.1.8 RADIATION PROTECTION SURVEYS

REQUIREMENTS:

1. A qualified expert in the design and operation of electron accelerator facilities shall perform a detailed radiation protection survey when the accelerator is first capable of producing radiation. Curricula vitae shall be forwarded to NAVSEADET RASO for evaluation prior to obtaining the services of a "qualified expert".

2. A radiation protection survey shall be performed and documented by a qualified expert when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas that could adversely affect radiation safety.

3. Radiation protection surveys for accelerators with maximum energies greater than 10 MeV shall:

a. Be conducted at the highest rated energy and current, or exposure rate.

b. Evaluate airborne radioactivity.

c. Evaluate neutron leakage.

d. Identify activated components and established radiological control procedures for maintenance and repair.

4. Radiation surveys shall be conducted in accordance with written procedures previously established by a qualified expert.

5. After operation of the accelerator, a radiation survey shall be conducted by the operator upon initial entry into an exposure room to verify the accelerator is off and to identify any radiation hazards due to neutron activation (for operation above 10 MeV).

6. Radiation surveys shall be conducted as necessary:

a. To determine and document that radiation doses received by non-radiation workers in unrestricted areas do not exceed the standards in NAVMED P-5055 (2 mrem in any one hour, 100 mrem in any seven consecutive days, or 500 mrem in a calendar year).

b. To determine that personnel in occupied areas are not exposed to excessive radiation levels due to incorrect or unusual accelerator operation.

c. To determine radiation levels and controls for auxiliary accelerator equipment which produces ionizing radiation.

**9.1.9 SPECIAL CONSIDERATIONS FOR ELECTRON ACCELERATORS
WITH ENERGIES EXCEEDING 10 MEV**

REQUIREMENTS:

1. Radiation safety programs, procedures, and surveys shall be reviewed at least annually by a qualified expert (staff member or consultant under contract).

2. LiF thermoluminescent dosimeters (TLDs) or other CHBUMED approved dosimetry shall be worn to measure gamma and neutron exposure.

3. Neutron energy correction factors shall be established for LiF TLDs. The neutron correction factor shall be established in accordance with BUMED survey procedures.

4. Procedures shall be established by the RSO or a qualified expert for the following:

a. Surveys for activation of accelerator components (e.g., targets, windows, collimators, beam dumps) prior to maintenance.

b. Surveys for activation of all material prior to removal from the accelerator facility. Material released for unrestricted use shall comply with surface contamination limits of Table 4.

5. Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words "CAUTION AIRBORNE RADIOACTIVITY AREA".

6. Exhaust air vents shall be located to prevent exhaust from being drawn in to nearby air intakes.

9.1.10 LOGS AND RECORDS

REQUIREMENTS:

1. RASP INSPECTIONS

- a. Records of formal inspections conducted to evaluate compliance with the Navy and Marine Corps RASP shall be maintained indefinitely.
- b. RASP inspection records shall include the inspection report and corrective actions.

2. TRAINING RECORD REQUIREMENTS

Training requirements are outlined in Section II, Part 2 of this manual.

- a. Records of initial qualification training shall be maintained indefinitely or until the individual is transferred to other duties or leaves the activity.
- b. Records of annual refresher training in radiation safety shall be maintained for three years.

3. RADIATION PROTECTION SURVEYS

Radiation protection survey reports and a record of corrective actions shall be retained indefinitely.

4. UTILIZATION OR OPERATION LOG

- a. The information contained in this log shall be as complete and accurate as possible to allow reconstruction of the conditions of the exposure if the need arises.
- b. A log shall be maintained for each accelerator of the command.
- c. Logs shall be retained indefinitely.
- d. Logs shall contain at least the following information:
 - (1) Machine identification.
 - (2) Energy, current or radiation output, duration of operation and date.
 - (3) Primary beam orientation.
 - (4) Name(s) of the operator(s) and signature of the Senior Operator.
 - (5) Model, serial number, and calibration dates of survey instrument(s)

used.

(6) Initials of the operator verifying that the RADIAC survey instruments have been source checked prior to the initial exposure of the day or shift.

(7) Initials of the operator certifying that all interlocks and alarms have been checked for proper operation before the initial exposure of the day or shift.

5. POCKET DOSIMETER LOG

a. Accelerator operations require establishing and maintaining a pocket dosimeter log.

b. It shall be retained for three years.

c. It shall contain the following minimum information:

(1) Command or activity name.

(2) Date of issue of the pocket dosimeter.

(3) Name of person issued to.

(4) Dosimeter serial number.

(5) Initial pocket dosimeter reading.

(6) Final pocket dosimeter reading.

(7) Net pocket dosimeter reading (final minus initial).

d. Entries shall be made in ink.

e. Entries are only required on days when operations are actually conducted.

f. A sample Pocket Dosimeter Log is attached as Appendix D.

6. RADIAC INSTRUMENT AND POCKET DOSIMETER CALIBRATION RECORDS

a. Records of calibration of RADIAC survey meters shall be maintained on file for three years from the date of last calibration. The calibration sheet for each instrument which is provided by the cognizant radiation calibration laboratory shall suffice for this record.

b. Records of response checks shall be maintained on file for six months from the last expiration date. The verification sheet provided by the cognizant radiation calibration laboratory will suffice for this record.

7. Radiation survey records shall be retained indefinitely and shall include the following information (when applicable):

- a. Date and time of survey.
- b. Beam energy and beam current.
- c. Type of target.
- d. Primary beam orientation.
- e. Location of collimator and magnets.
- f. Purpose of survey, identification of survey meter, and calibration date.
- g. Location of survey.
- h. Results and recommendations.
- i. Individual(s) performing the survey.

9.2 ELECTRON BEAM WELDERS

DISCUSSION:

Electron beam welders use a concentrated beam of high velocity electrons. The velocity of the electrons is sufficient to produce low-energy x-rays as a byproduct of the welding process. Welding usually takes place in an evacuated chamber containing the beam generating and focusing devices.

REQUIREMENTS:

1. Electron beam welders shall be surveyed at least quarterly, prior to first use in a quarter, with an ion chamber RADIAC instrument.
2. The survey shall include the high voltage power supply, the welding chamber, and the operator's control station.
3. Radiation levels at two inches from any surface shall be less than 0.5 mrem/hour.

9.3 KLYSTRON AND CATHODE RAY TUBES

DISCUSSION :

Electron tubes operated at a potential greater than 10 kV may produce x-radiation which requires protection of personnel during operation and maintenance. Cathode ray tubes, associated high voltage rectifier tubes, microwave power amplifier tubes such as

klystrons, transmitting pulse amplifier tubes, and hydrogen thyratron tubes operate at potentials which can produce x-rays. Klystron tubes operate at potentials up to several hundred kilovolts and can produce significant external x-ray radiation levels.

REQUIREMENTS:

1. Klystron tubes and other tubes when operated at greater than 10 kV shall be shielded during routine operation and maintenance. Each shield shall be labeled "CAUTION (Radiation Symbol) – X-Rays Emitted When Operated. Do Not Operate with Shielding Removed". Appropriate shields shall be identified in the technical manual.
2. Radiation levels shall not exceed 0.5 mrem/hour at five centimeters (two inches) from external surfaces of cabinets or enclosures containing the tubes.
3. Radiation levels shall be measured as required with radio-frequency shielded, thin-window ion chamber RADIAC instruments.
4. If excessive radiation levels are suspected, and not otherwise covered by a class fix for the radar, request technical assistance in accordance with Section I.

9.4 RADIATION SAFETY REQUIREMENTS FOR ANALYTICAL X-RAY EQUIPMENT

9.4.1 GENERAL

DISCUSSION:

This part provides special requirements for analytical x-ray equipment used for x-ray diffraction or fluorescence analysis. The requirements here are in addition to applicable requirements in other parts of this manual.

REQUIREMENTS:

1. A RSO shall be appointed in writing and qualified per Section II, Part 2 of this manual.
2. Training. No individual shall be permitted to operate or maintain analytical x-ray equipment unless such individual has received instruction from the RSO in and has demonstrated competence in identification of equipment radiation hazards, operating and emergency procedures, warning system, safety precautions, and reporting of actual or suspected exposures.
3. Standard operating procedures shall be written and provided to all operators and their supervisors. No individual shall be permitted to operate equipment in any manner other than that specified in the procedures unless the individual has obtained prior

written approval from the RSO. Standard operating procedures include sample insertion and manipulation, equipment alignment, and maintenance.

4. Manufacturer's or special alignment procedures shall be used when available and shall be approved in writing by the RSO.

9.4.2 OPEN AND ENCLOSED BEAM SYSTEMS

REQUIREMENTS:

1. GENERAL

a. The dose due to stray radiation from components such as high voltage rectifiers shall not exceed 10 mrem in a week at any accessible location five centimeters from the outside surface of the generator cabinet. If an individual may be near the operating equipment for as long as 40 hours per week, the exposure rate shall not exceed 0.25 mR/hour at five centimeters.

b. The x-ray accessory apparatus shall include a beam trap or other barrier with sufficient shielding so that the exposure rate from the transmitted primary beam does not exceed 0.25 mR/hour under normal operating conditions. This requirement is met if the inherent shielding on the trap or barrier is at least equivalent to the thickness of lead specified in the table below for the maximum rated anode current and potential.

THICKNESS OF LEAD REQUIRED FOR A PRIMARY BEAM BARRIER LOCATED FIVE CENTIMETERS FROM THE FOCAL SPOT

ANODE CURRENT (mA)	THICKNESS OF LEAD (mm)		
	50 kVp	70 kVp	100 kVp
20	1.5	5.6	7.7
40	1.6	5.8	7.9
80	1.6	5.9	—
160	1.7	—	—

c. A fail-safe warning light or device labeled "X-RAYS ON", or other similar words shall be located near any switch which energizes the x-ray tube.

d. A fail-safe light or indicator in a conspicuous location near the radiation source housing shall be used to indicate when the x-ray tube is on.

e. The control panel of each analytical x-ray unit shall be equipped with a key-operated power switch, which shall prevent the production of x-rays when in the

"off" position. The "on" and "off" positions shall be clearly marked and the key shall be removable only when the switch is in the "off" position.

f. A label bearing the conventional radiation symbol and the words "CAUTION: THIS EQUIPMENT PRODUCES X-RAYS WHEN ENERGIZED – TO BE OPERATED ONLY BY QUALIFIED PERSONNEL", or other similar words shall be attached near any switch which energizes an x-ray tube.

g. Each x-ray tube housing shall be equipped with an interlock that shuts off the tube if it is removed from the radiation source housing or if the housing is disassembled.

2. OPEN BEAM SYSTEM

a. All personnel working with open beam analytical x-ray equipment shall be considered as occupationally exposed individuals and requirements of NAVMED P-5055 apply.

b. A primary dosimeter shall be worn on the upper chest or collar.

c. Finger ring TLDs or wrist dosimeters shall be provided to and shall be used by:

(1) Operators using open-beam systems not equipped with a safety device;

AND

(2) Personnel maintaining the equipment, if the maintenance procedures require the primary x-ray beam be turned on when any local component in the system is disassembled or removed.

d. Annotation of exposure to low-energy highly collimated x-rays shall be made on the dosimetry report submitted with the dosimeters for processing.

e. All shutters shall have a fail-safe "shutter open" indicator.

f. Radiation levels external to the x-ray tube housing with all shutters closed shall not exceed 2.5 mR/hour measured at five centimeters from the surface of the housing when the x-ray tube is operated at full rated power at maximum rated potential.

g. Each port of the source housing shall be provided with a beam shutter interlocked with the x-ray accessory apparatus coupling or collimator so that the port shall be open only when the collimator or coupling is in place. Shutters at unused ports shall be secured to prevent casual opening.

h. A guard or interlock shall prevent entry of any part of the body into the primary beam.

i. Radiation exposure levels near controls and adjustments of the x-ray accessory apparatus shall not exceed 37.5 mR/hour to the hands or 2.5 mR/hour to the whole body or lens of the eye.

3. ENCLOSED BEAM X-RAY SYSTEM

a. All personnel working with enclosed beam x-ray systems which meet all design requirements listed in this section may be classified as non-occupationally exposed individuals.

b. The radiation source, sample, detector and analyzing crystal (if used) shall be enclosed in a chamber or coupled chambers that excludes any part of the body during normal operation.

c. The inherent shielding of the chamber walls shall be sufficient to limit the exposure rate at five centimeters from the outer wall surface to 0.25 mR/hour during normal operation.

d. The sample chamber closure shall be interlocked with the x-ray tube high voltage supply or a shutter in the primary beam so that no x-ray beam can enter the sample chamber while it is open unless the interlock has been consciously and deliberately defeated.

e. The interlock shall be a fail-safe design.

f. The requirements of Section 9.4.3 apply to each port and each x-ray tube in the x-ray system.

9.4.3 OPERATIONS

REQUIREMENTS:

1. Rooms housing analytical x-ray systems shall be designated as restricted areas. The dose to an individual in the surrounding area shall not exceed 0.25 mR/hour (10 mR/week). This limit shall be met at any specified tube rating.

2. Safety devices or interlocks shall not be bypassed unless prior written approval has been obtained from the RSO. Such approval shall be for a specific period of time. When a safety device or interlock has been bypassed, a readily discernible sign bearing the words "SAFETY DEVICE INOPERATIVE", or similar words, shall be placed on the tube housing.

3. Repair or Modification of X-Ray Tube Systems. Except as specified in Article 9.4.5.2, no operation involving removal of covers, shielding materials or tube housings or modifications to shutters, collimators, or beam stops shall be performed

without determining that the tube is off and will remain off until safe conditions have been restored. The main switch, rather than interlocks, shall be used for routine shutdown in preparation for repairs.

4. If an alignment procedure may result in increasing the exposure rate in an area, temporary barriers and warning signs shall be erected and surveillance of the area maintained until normal operation has been restored.

5. After reassembly, the x-ray system shall be checked by the RSO. Particular attention shall be given to alignment of shielding, shutters and collimators.

6. Each area or room containing the equipment shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words "CAUTION – X-RAY EQUIPMENT".

7. No accessory shall be aligned or operated until procedures have been reviewed and a radiation survey conducted by the RSO.

8. The RSO shall be notified whenever alignment or repair operations are undertaken.

9.4.4 SURVEYS

REQUIREMENTS:

1. Radiation surveys of all systems sufficient to show compliance with this part shall be performed:

- a. Upon installation of the equipment and at least semi-annually;
- b. Following any change in the initial arrangement;
- c. Following any maintenance requiring the disassembly or removal of a local component in the system;
- d. During maintenance and alignment if the procedures require the presence of a primary x-ray beam when any local component in the system is disassembled or removed;
- e. Any time a visual inspection of the local components in the system reveals an abnormal condition; and
- f. Whenever personnel monitoring devices show a significant increase in doses over the previous monitoring period or the readings are approaching the limits specified in NAVMED P-5055.

2. An ionization chamber survey instrument with a thin window (7.0 mg/cm² or less) shall be used to measure radiation levels for compliance with this part. Corrections

for narrow beams shall be made. An acceptable method to determine the cross sectional area of a narrow beam is using 14 x 7 inch chest x-ray film at the standard required distance. The beam correction factor (f) for narrow beams is given by the formula:

$$f = \frac{A_{\text{detector}}}{A_{\text{beam}}}$$

where A detector = cross sectional area of the detector

A beam = cross sectional area of the beam

For very small beam sizes use A beam = one square centimeter.

3. Geiger-Mueller survey meters with thin windows may be used to detect small beams and leakage for checking shielding or alignment. However, they shall not be used to quantify radiation levels.

9.4.5 RECORDS

REQUIREMENTS:

1. Survey records shall include the date, system parameters (tube anode material, kV, mA, survey meter, model number, serial number, calibration date), and results (data, discussion, recommendations and corrective actions when applicable).

2. Training records shall include dates, names of persons trained, and a topic summary.

3. Utilization logs shall include date of use, exposure time, machine parameters, and target material.

4. The following records shall be maintained indefinitely:

a. Surveys prior to placing a new or modified machine in service or after a change in location.

b. Surveys made to establish dose estimates in exposure investigations.

5. The retention period for other records shall be three years unless otherwise specified.

9.5 ELECTRON MICROSCOPES

DISCUSSION:

Electron microscopes are operated at voltages and currents which produce x-rays. When properly designed, shielded, operated, maintained and supervised, few possibilities for personnel radiation exposure can exist.

REQUIREMENTS:

1. All personnel working with electron microscopes which meet all radiation safety requirements of this section may be classified as non-occupationally exposed individuals.
2. An RSO and ARSO shall be appointed in writing and qualified per Section II, Part 2 of this manual.
3. Training. No individual shall be permitted to operate or maintain the units until instruction has been received in:
 - a. The radiation hazards associated with the equipment.
 - b. Operating and emergency procedures, including identification of abnormal operating conditions.
4. All meters, lights, indicators and user controls shall be clearly labeled. A standard radiation warning sign shall be permanently affixed to the external surface of the unit with a label stating "Caution – Produces X-ray When On" or words to that effect.
5. The control panel shall be equipped with a removable key operated power switch.
6. Radiation levels shall not exceed 0.5 mrem per hour five centimeters from any external surface of the unit. If radiation levels exceed this limit, the unit shall not be used until corrected.
7. Standard operating procedures shall be established, explained and copies given to each operator, and a copy posted at the control console.
8. Routine operations shall not be permitted when shields are removed or cabinet doors are open.
9. Non-standard accessories shall not be installed, aligned or operated until inspected and approved by the RSO.
10. Operations shall be suspended and the RSO notified when any unusual operating conditions (high beam current, dark current, or extra bright beam) or suspected deficiencies are noted.
11. Keys to the power switch shall be removed from the console and controlled when not in use.
12. A radiation survey shall be performed by the RSO semi-annually and as follows:

- a. Prior to placing a new unit in service.
- b. Immediately after maintenance or repair.
- c. After shock, earthquake, etc., or suspected deficiency.
- d. When major beam realignment is in progress.
- e. Whenever equipment is modified.

13. Semi-annual surveys shall be retained for three years. Situational surveys listed in paragraphs 12.a through 12.e shall be maintained indefinitely.

14. Measurements shall be made with the unit operating at a voltage and beam current which yields the highest output. The radiation survey shall include the viewing column area, high voltage power supply, lens column, penetrations into the column, control console, and electron beam target area. For high voltage electron microscopes (greater than 200 kVp), the high voltage generator tanks shall also be surveyed. Installed interlocks shall be tested under actual use conditions.

15. Radio-frequency shielded ion chambers, IM-231A (or B)/PD or equivalent, shall be used to quantify radiation levels. Geiger-Mueller type RADIAC instruments shall not be used for this purpose.

SECTION X

SOURCE MATERIAL

10.1 DEPLETED URANIUM

DISCUSSION:

Depleted Uranium (DU) is a heavy metal used as ballast or counterweights in aircraft gyroscope assemblies, flight control surfaces, helicopter blade assemblies, elevator balance assemblies, aileron balance assemblies, etc., in aircraft, rockets, projectiles, and missiles; and as penetrators in certain ammunition. DU is natural uranium that has most of the uranium-235 and uranium-234 atoms removed.

10.1.1 DEPLETED URANIUM COUNTERWEIGHTS

DISCUSSION:

Plated DU counterweights for use in aircraft are manufactured and distributed under a general NRC license granted in 10 CFR 40.13(5) and therefore do not require a NRMP. The general license prohibits chemical, physical, or metallurgical treatment or processing of counterweights other than repair or restoration of the plating or covering on the counterweight. Any use of these counterweights other than for their intended purpose in aircraft requires the issue of a specific NRMP. Personnel involved in the handling, use and distribution of these counterweights shall comply with the radiological control requirements of this manual.

REQUIREMENTS:

1. DU counterweights shall only be used as counterweights in Navy and Marine Corps aircraft and they shall never be transferred to personnel or organizations for any purpose other than use in aircraft.
2. DU counterweights shall not physically be transferred to Defense Reutilization Marketing Offices (DRMOs) for resale. Aircraft parts such as wings and helicopter blades containing DU counterweights shall be stripped of counterweights prior to disposal or resale by DRMOs.
3. No attempt shall be made to clean corrosion from DU counterweights. DU counterweights with corroded surfaces or chipped or peeled cladding shall be painted to seal the material, placed in plastic bags and returned to a manufacturer for repair or disposal. When replacement counterweights are not available, the counterweight shall be painted to seal potential contamination and the counterweight may be reinstalled on the aircraft until a replacement is available.

4. When performing work on aircraft where DU counterweights are close (less than 36 inches) to the eyes or trunk of the body, exposures shall be minimized by either removing the counterweight from the aircraft or shielding it by placing lead foil over the counterweight.

5. Corroded or damaged counterweights may be returned to an authorized manufacturer for repair or disposal in accordance with paragraph 7 below.

6. DU counterweights which are in serviceable condition may be returned to an authorized manufacturer for disposal in accordance with paragraph 7 below provided:

a. The counterweights have been offered for use by other Navy and Marine Corps aviation units operating or repairing similar aircraft.

b. The counterweights have been offered for use by other U.S. armed forces operating or repairing similar aircraft.

7. NAVSEADET RASO shall provide specific authorization for all transfers of counterweights from Navy and Marine Corps activities to any civilian activity. Requests for authorization to transfer counterweights to a manufacturer shall be submitted to NAVSEADET RASO by letter or message. Upon receipt of a transfer authorization request, NAVSEADET RASO shall provide packaging, marking, documentation and transportation requirements for the specific shipment. Upon assurance that all NRC and DOT regulations are met, NAVSEADET RASO shall provide authorization for shipment of the counterweights to a specific manufacturer.

10.1.2 DEPLETED URANIUM PROJECTILES

DISCUSSION:

The Navy and Marine Corps use DU projectiles in 20mm CIWS rounds, 30mm GAU 12 aircraft rounds, 105mm and 120mm artillery projectiles. These DU sources are not exempt from NRC licensing requirements but are used under a specific NRMP. The NRMP is issued to the item manager (Naval Weapons Support Center, Crane) and not to each command which stores or uses the projectiles.

REQUIREMENTS :

1. The item manager shall maintain a NRMP for storage, handling and transportation of DU ammunition.

2. The item manager shall provide copies of the approved NRMP to each Navy and Marine Corps command which will handle, store and transport the DU ammunition.

3. Navy and Marine Corps commands which store, or handle DU ammunition shall comply with all requirements contained in the applicable NRMP.

4. DOT exemptions shall constitute exemption from transportation requirements of this manual.

10.1.3 OTHER DEPLETED URANIUM SOURCES

REQUIREMENT:

All other uses of DU which are not exempted in 10 CFR 40.13 or authorized on a general license in 10 CFR 40.22 shall require a NRMP to be issued prior to possession and use.

10.2 THORIUM

DISCUSSION:

Thorium is a naturally occurring radionuclide contained in various manufactured items such as incandescent gas mantles, welding rods, lenses, and aircraft engine parts. Manufactured items exempted in 10 CFR 40.13 or authorized by a general license in 10 CFR 40.22 do not require a NRMP. Grinding of thoriated tungsten electrodes can produce surface contamination.

10.2.1 THORIATED TUNGSTEN WELDING RODS

REQUIREMENTS:

1. Isolate grinding areas by providing a separate grinding booth or room.
2. Provide exhaust ventilation for the grinding booth or room.
3. Clean the grinding area after each shift, when used, by vacuum cleaning or wiping.
4. Dispose of grinding dust, chips and cleaning rags as normal waste materials as it is generated.
5. Use wet belt grinding machines to contain dust.
6. Ensure adequate ventilation by welding in large open areas whenever possible.
7. In enclosed or restricted areas, provide dust respirators (3M Model 9940 or equivalent) for workers or provide adequate ventilation by hood or portable duct. Hoods, enclosures and portable ducts shall be designed and operated to the requirements of the latest edition of "Industrial Ventilation", American Conference of Governmental Industrial Hygienists. The face velocity for portable ducts shall be at least 1,500 feet per minute.

CAUTION:

When welding, the location of the exhaust air duct and the airflow rate should not produce a draft across the arc that would disturb the inert gas shield around the arc.

**10.2.2 REPAIR AND PROCESSING OF MAGNESIUM–THORIUM ALLOY
MANUFACTURED PARTS**

Magnesium–thorium is commonly used in gear boxes and other manufactured aircraft parts. Chemical, physical (including filing or grinding), or metallurgical treatment or processing of any manufactured parts requires a NRMP.

SECTION XI
SPECIAL NUCLEAR MATERIAL
(RESERVED)

BLANK

SECTION XII

OTHER SOURCES OF IONIZING RADIATION

12.1 PORTABLE GAUGES

DISCUSSION:

This section establishes specific requirements for portable gauging devices which are in addition to the general radiation safety programs requirements of a NRMP.

REQUIREMENTS:

1. Portable gauges (e.g., nuclear moisture density meters) containing radioactive material shall be used by or under the supervision of and in the physical presence of an individual trained per the requirements of a NRMP.
2. Portable gauges shall be secured against access or removal by unauthorized personnel when not in use or under the direct surveillance of an individual trained per the requirements of a NRMP (including transportation to a temporary job site).
3. When not in use, portable gauges shall be stored in secure, properly posted (see Section 2.6) storage areas which are not normally occupied.

12.2 GAS CHROMATOGRAPHS

DISCUSSION:

Gas chromatographs use millicurie amounts of radioactive material (commonly nickel-63 or tritium) under general NRC licenses or a NRMP.

REQUIREMENTS:

1. Gas chromatograph detector cells authorized by a NRC general license shall be:
 - a. Leak tested per manufacturer's instructions.
 - b. Returned to the manufacturer when operations with the gas chromatograph are terminated.
2. Gas chromatograph detector cells shall be secured against unauthorized access when not in use.
3. Gas chromatographs using tritium (hydrogen-3) shall be vented to the outside atmosphere or to a fume hood vented to the outside atmosphere.

BLANK

SECTION XIII

GLOSSARY

ABNORMAL OCCURRENCE

Failure to meet conditions required for the safe operation of radiation producing equipment or safe use of radioactive material.

ABSORBED DOSE

The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad. One rad equals 100 ergs/gm.

ACCOUNTABILITY

Quantitative accounting for nuclear material inventories and transfers through a system of measurements, records and reports.

AIRBORNE RADIOACTIVE MATERIAL

Any radioactive material dispersed in air in the form of dusts, fumes, mists, vapors or gases.

ALARA

Concept of controlling the possession, use and transfer of radioactive material or a radiation producing machine in such a way that the total dose to the individual worker is kept as low as reasonably achievable (ALARA) considering the state of technology and the economics of improvement versus the benefits to public health and safety, and consistent with the purpose for which the activity is undertaken.

AUTHORIZED USER

An individual that uses or operates a radiation source item, who has had the appropriate training and is determined by the Radiation Safety Officer (RSO) to be qualified to work with radioactive material.

BYPRODUCT MATERIAL

Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material.

CALIBRATION

The act of standardizing by determining the variation or deviation from a standard so as to ascertain the proper correction factors.

COMMAND

Includes any Navy or Marine Corps facility or activity.

CONTAMINATED AREA

An area where surface contamination exceeds the values of Table 4.

CONTAMINATION

The presence of radioactive material where it is not wanted.

CONTROLLED AREA

Any area in which radioactive material or radiation producing devices are used or stored and access to which is controlled for the protection of individuals from exposure to radiation.

DOSE

The total quantity of radiation absorbed per unit mass during a specific time period. For special purposes, it must be appropriately qualified. If not qualified, it refers to absorbed dose.

DOSE EQUIVALENT

A quantity used in radiation protection to express all radiations on a common scale for calculating the effective absorbed dose. Defined as the product of the absorbed dose in rads and certain modifying factors. The unit of dose equivalent is the rem.

DOSIMETRY (PERSONNEL MONITORING EQUIPMENT)

Devices designed to be worn or carried by an individual for the purpose of detecting and measuring an individual's exposure to ionizing radiation.

EXEMPT SHIELDED FACILITY

An x-ray radiography facility which meets all of the requirements found in Section 4.3 of this manual. This is inherently the safest type of x-ray radiography facility because the protection does not depend on compliance with any operating limitations.

EXPOSURE

(1) TECHNICAL

A measure of the ionization produced in air by photons (x- or gamma rays); or sum of the electrical charge on all ions of one sign produced in air when electrons liberated by photons are completely stopped in air, divided by the mass of the air in the volume element. The unit of exposure is the roentgen.

(2) GENERAL

The act of an individual receiving a dose of radiation.

FACILITY

The location at which one or more devices or sources of ionizing radiation are installed or located within one building, vehicle or under one roof and are under the same administrative control.

FACILITY RE-EVALUATION

An evaluation of an existing facility due to a change in equipment, shielding, workload, or occupancy in adjacent areas.

FAIL-SAFE DESIGN

One in which all failures of indicator or safety components that can reasonably be anticipated cause the equipment to fail in a mode such that personnel are safe from exposure to radiation.

GENERAL PUBLIC

For the purposes of this manual, individuals not occupationally associated with a facility or organization shall be considered members of the general public.

HIGH RADIATION AREA

Any area accessible to personnel in which radiation exists at such levels that a major portion of the body could receive a dose in excess of 100 mR in any one hour.

INTERLOCK

A device for precluding access to an area of radiation hazard, either by preventing entry or automatically removing the hazard.

INTERNAL AUDIT AND INSPECTION

A documented examination by responsible management individual (i.e., Radiation Safety Officer, Assistant Radiation Safety Officer, Senior Radiographer, supervisor,

foreman, etc.) of the radiation safety program or any element thereof (training, posting, operations, procedures, records, etc.) to verify compliance with requirements and established procedures.

INTERNAL RADIATION

Radiation from a source within the body as a result of deposition of radionuclides in body tissues.

IONIZATION

Process by which a neutral atom or molecule, or ion gains or loses electrons.

IONIZING RADIATION

Electromagnetic or particulate radiation capable of producing ion pairs in its passage through matter.

INITIAL FACILITY EVALUATION

An evaluation of an x-ray radiography facility to determine its classification as an exempt shielded, shielded, or open facility prior to placing a facility into routine operation. A radiation protection survey will provide the basis for the facility evaluation. Facility evaluations will be conducted by NAVSEADET RASO using data provided in radiation protection surveys by the local Radiation Safety Officer/Assistant Radiation Safety Officer.

ISOTOPE

Nuclides that have the same number of protons in their nuclei (the same atomic number) but different numbers of neutrons (different mass numbers).

LEAK TEST

A test to determine if a sealed source has lost its integrity and allows leakage of radioactive material through holes or cracks. The test is normally performed by wiping the source with filter paper or absorbent material to determine the presence of radioactive contamination which indicates a leakage.

LICENSE EXEMPT MATERIAL

Items containing radioactive material not subject to Nuclear Regulatory Commission (NRC) regulations or radioactive material exempt from licensing by the NRC as specified in 10 CFR or in a specific license issued by the NRC or state.

LICENSED MATERIAL

Radioactive material that is received, possessed, used or transferred under a general or specific license issued by the Nuclear Regulatory Commission.

MILLICURIE

One thousandth of a curie (3.7×10^7 disintegrations per second). Abbreviated mCi.

NAVY RADIOACTIVE MATERIALS PERMIT (NRMP)

Authorization issued by the Navy Radiation Safety Committee for accelerator produced radioactive material and in lieu of a specific Nuclear Regulatory Commission license for the receipt, possession, use or transfer of licensable radioactive material.

OCCUPANCY

The type and degree that an area is occupied by personnel. The type of occupancy refers to the activity in the area such as office, berthing, utility room or closet. The degree of occupancy is the fraction of time the area is occupied. The degree should be locally measured.

OPEN FACILITY

An x-ray radiography facility which meets all the specific requirements found in Section 4.5 of this manual. Open facilities have few or no fail-safe mechanical controls and primarily rely on strict adherence to safe operating procedures for radiation safety.

PERMANENT RADIOGRAPHIC INSTALLATION

A shielded installation or structure designed or intended for radiography and in which radiography is regularly performed.

PRIMARY SHIELDING BARRIER

A barrier sufficient to attenuate the primary beam to the required level for the classification of exposure facility.

QUALIFIED EXPERT

A person having the knowledge and training to advise regarding radiation protection needs, to measure ionizing radiation and to evaluate safety techniques. Board certification or eligibility under the criteria established by the American Board of Health Physics or American Board of Radiology is considered as prima facie evidence of such qualification.

QUALITY FACTOR

A factor used for radiation protection purposes that accounts for differences in biological effectiveness between different radiations.

QUARTER (CALENDAR)

A period of time not less than 12 consecutive weeks nor more than 14 consecutive weeks.

QUICK SCAN RADIATION SURVEY

A survey conducted by moving an instrument over a specific area anticipated to be the most likely source of leakage at a slow enough movement rate to allow adequate response and noting the highest reading observed.

RAD

The unit of absorbed dose equal to the absorption of energy in the amount of 100 ergs/gram of any material. For the purpose of this manual, one rad is considered to be the dose delivered by one roentgen of x- or gamma radiation.

RADIATION

For purposes of this manual, any or all of the following ionizing radiations: alpha, beta, gamma or x-rays, neutrons, high-speed electrons, high-speed protons and other atomic particles; but does not include sound or radiowaves or visible, infrared or ultraviolet light.

RADIATION AREA

Area in which an individual could receive a radiation dose of five mrem or more in any one hour or 100 mrem or more in any five consecutive days.

RADIATION INCIDENT

Unplanned loss of control of radioactive or machine sources which result in overexposures or excessive levels as defined in Article 2.10.

RADIATION MACHINE

Any device or equipment capable of generating ionizing radiation when the associated control panel area is operated, but excluding devices which produce radiation only by the use of radioactive materials.

RADIATION PROTECTION SURVEY

An evaluation of the radiation hazards incident to the production, use, release, disposal or presence of radioactive material or other sources of radiation under a specific set of conditions including a physical survey of the location of materials and equipment and measurements of levels of radiation.

RADIATION SAFETY OFFICER

A qualified individual, appointed by the Commanding Officer, who is responsible for those activities which will assure adequate radiation protection.

RADIOACTIVE COMMODITY

An item of government property composed in whole or part of radioactive material, or any item that contains radioactivity equal to or in excess of limits established in 10 CFR 20, Appendix C or contains a specific activity greater than 0.002 microcuries per gram of radioactive material and is license/NRMP exempt to the end user.

RADIOACTIVE DEVICE

Manufactured article having radioactive material in a nondispersable form (non-liquid) as a component part.

RADIOACTIVE MATERIAL

Any material or combination of materials which spontaneously emit ionizing radiation.

RADIOACTIVE WASTE

Any radioactive material that meets all of the following conditions: (1) material no longer needed or usable by the Navy; (2) material cannot be returned to the manufacturer; (3) material requires controlled disposal; and (4) material has been declared to be waste by an inventory control point.

RADIOGRAPHIC EXPOSURE DEVICE

Any device containing a sealed source which can be unshielded for purposes of making a radiographic exposure.

RADIOGRAPHER

Any individual who performs radiography or who in attendance at the site, personally supervises radiographic operations and who is responsible to the Commanding Officer for assuring compliance with the requirements of this manual for machines and the Nuclear Regulatory Commission rules and regulations and the

conditions of the Navy Radioactive Materials Permit for NRC licensed radioactive material.

RADIOGRAPHY

The examination of the structure of material by nondestructive methods utilizing sealed sources of radioactive material or radiation producing machines.

RADIOLOGICAL ACCIDENT

Loss of control of radiation or radioactive material which presents a hazard to life, health or property, or which may result in any member of the general population exceeding exposure limits for ionizing radiation.

REM

The special unit of dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor.

RESTRICTED AREA

Any area access to which is controlled by the command for purposes of protection of individuals from exposure to radiation and radioactive material.

ROENTGEN

The special unit of x-ray or gamma exposure. One roentgen produces 2.58×10^{-4} coulombs/kilogram of air.

SEALED SOURCE

Any radioactive material that is encased in a capsule designed to prevent leakage or escape of radioactive material.

SECONDARY SHIELDING BARRIER

A barrier which will not be used to attenuate the primary beam but which is sufficient to attenuate the scattered, leakage and stray radiation.

SENIOR RADIOGRAPHER

The qualified individual appointed by the Commanding Officer to supervise radiographic operations.

SHIELDED FACILITY

An x-ray radiography facility which meets all of the requirements found in Section 4.4 of this manual. The shielding requirements are lower than for exempt shielded facilities and there is reliance on administrative controls. The inherent protection is such that the possibility of significant exposure is remote. This will be the facility of choice where reduced weight of shielding and small size are a premium.

SIGNIFICANT ABNORMAL OCCURRENCE

An abnormal occurrence which is not reportable as a radiation accident or incident but results in evident damage or requires immediate action in the interest of safety or security.

SOURCE CHANGER

Any device designed and used for replacement of sealed sources in radiographic exposure devices including those also used for transporting and storage of sealed sources.

SOURCE MATERIAL

Uranium or thorium or any combination thereof in any physical or chemical form or ores which contain by weight 1/20 of one percent (0.05%) or more of uranium and/or thorium but not including special nuclear material.

SPECIAL NUCLEAR MATERIAL

Plutonium, uranium-233, uranium enriched in the isotope 233 or isotope 235, or any material artificially enriched by the foregoing but not including source material.

STOCKING ACTIVITY

Any activity assigned responsibility to store, maintain or possess radioactive material.

SUBSTANTIAL SAFETY HAZARD

A loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety from any NRC licensed activity. Examples include: Hb

(1) Moderate exposure to or release of radioactive material; e.g., an acute personnel whole body occupational exposure exceeding 25 rem, or exceeding 0.5 rem per year in an uncontrolled area (member of the general public).

(2) Major degradation of or deficiencies in essential safety related equipment such as radiation alarm systems.

(3) Major deficiencies involving use of licensed material or facilities.

SURPLUS RADIOACTIVE MATERIAL

Any radioactive material that is no longer needed by a using activity. Includes radioactive sources, manufactured products containing radioactive material and items contaminated with radioactive material.

TYPE "A" PACKAGING

A packaging designed to retain the integrity of containment and shielding required by 49 CFR under normal conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465 or 173.466, as appropriate.

TYPE "B" PACKAGING

A packaging designed to retain the integrity of containment and shielding required by 49 CFR when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR 71.

UNRESTRICTED AREA

Any area access to which is not controlled by the command for purposes of protection of individuals from exposure to radiation or radioactive materials and any area used for residential quarters.

APPENDIX D

SAMPLE POCKET DOSIMETER LOG

[illegible]

BLANK

TABLE 1

**NATURALLY OCCURRING RADIOACTIVE MATERIALS
(THIS IS NOT NECESSARILY A COMPLETE LIST)**

HYDROGEN-3	HAFNIUM-174
BERYLLIUM-7	LUTECIUM-176
BERYLLIUM-10	RHENIUM-187
CARBON-14	PLATINUM-190
SODIUM-22	PLATINUM-192
SILICON-32	LEAD-204
PHOSPHORUS-32	LEAD-210
PHOSPHORUS-33	LEAD-212
SULFUR-35	BISMUTH-210
CHLORINE-36	BISMUTH-212
CHLORINE-39	POLONIUM-210
POTASSIUM-40	RADIUM-226
VANADIUM-50	
RUBIDIUM-87	
INDIUM-115	
LANTHANUM-138	
CERIUM-142	
NEODYMIUM-144	
SAMARIUM-147	
SAMARIUM-149	
GADOLINIUM-152	

BLANK

T1-2

TABLE 2

**ACCELERATOR-PRODUCED RADIOACTIVE MATERIALS
(THIS IS NOT NECESSARILY A COMPLETE LIST)**

CARBON-11	ARSENIC-73	DYSPROSIUM-157
NITROGEN-13	SELENIUM-73	OSMIUM-190
OXYGEN-15	BROMINE-77	IRIDIUM-190
FLUORINE-18	KRYPTON-77	IRIDIUM-190M ₁
SODIUM-22	KRYPTON-81	PLATINUM-193M
MAGNESIUM-28	RUBIDIUM-81	GOLD-195
ALUMINUM-28	RUBIDIUM-82	MERCURY-197
PHOSPHORUS-33	RUBIDIUM-84	THALLIUM-199
ARGON-37	STRONTIUM-82	LEAD-209
POTASSIUM-43	STRONTIUM-87M	BISMUTH-204
SCANDIUM-49	YTTRIUM-87	
MANGANESE-52	TECHNETIUM-97M	
IRON-52	IRIDIUM-111	
COBALT-57	IODINE-123	
COBALT-58	IODINE-124	
COPPER-67	IODINE-125	
ZINC-62	XENON-127	
GALLIUM-66	CESIUM-131	
GERMANIUM-68	PROMETHIUM-145	

BLANK

TABLE 3
EXEMPT QUANTITIES
(INCLUDES NARM AND BY PRODUCT MATERIAL)

<u>RADIOACTIVE MATERIAL</u>	<u>MICROCURI</u>
ANTIMONY-122 (Sb-122)	100
ANTIMONY-124 (Sb-124)	10
ANTIMONY-125 (Sb-125)	10
ARSENIC-73 (As-73)	100
ARSENIC-74 (As-74)	10
ARSENIC-76 (As-76)	10
ARSENIC-77 (As-77)	100
BARIUM-131 (Ba-131)	10
BARIUM- 133 (Ba-133)	10
BARIUM-140 (Ba-140)	10
BISMUTH-210 (Bi-210)	1
BROMINE-82 (Br-82)	10
CADMIUM-109 (Cd-109)	10
CADMIUM-115M (Cd-115m)	10
CADMIUM-115 (Cd-115)	100
CALCIUM-45 (Ca-45)	10
CALCIUM-47 (Ca-47)	10
CARBON-14 (C-14)	100
CERIUM-141 (Ce-141)	100
CERIUM-143 (Ce-143)	100
CERIUM-144 (Ce-144)	1
CESIUM-129 (Cs-129)	100
CESIUM-131 (Cs-131)	1,000
CESIUM-134M (Cs-134m)	100
CESIUM-134 (Cs-134)	1
CESIUM-135 (Cs-135)	10
CESIUM-136 (Cs-136)	10
CESIUM-137 (Cs-137)	10
CHLORINE-36 (Cl-36)	10
CHLORINE-38 (Cl-38)	10
CHROMIUM-51 (Cr-51)	1,000
COBALT-57 (Co-57)	100
COBALT-58M (Co-58m)	10

EXEMPT QUANTITIES

(INCLUDES NARM AND BY PRODUCT MATERIAL) – CONT.

COBALT-58 (Co-58)	10
COBALT-60 (Co-60)	1
COPPER-64 (Cu-64)	100
DYSPROSIUM-165 (Dy-165)	10
DYSPROSIUM-166 (Dy-166)	100
ERBIUM-169 (Er-169)	100
ERBIUM-171 (Er-171)	100
EUROPIUM-152 (Eu-152) 9.2H	100
EUROPIUM-152 (Eu-152) 13 YR	1
EUROPIUM-154 (Eu-154)	1
EUROPIUM-155 (Eu-155)	10
FLUORINE-18 (F-18)	1,000
GADOLINIUM-153 (Gd-153)	10
GADOLINIUM-159 (Gd-159)	100
GALLIUM-67 (Ga-67)	100
GALLIUM-72 (Ga-72)	10
GERMANIUM-71 (Ge-71)	100
GOLD-198 (Au-198)	100
GOLD-199 (Au-199)	100
HAFNIUM-181 (Hf-181)	10
HOLMIUM-166 (Ho-166)	100
HYDROGEN-3 (H-3)	1,000
INDIUM-111 (In-111)	100
INDIUM-113M (In-113m)	100
INDIUM-114M (In-114m)	10
INDIUM-115M (In-115m)	100
INDIUM-115 (In-115)	10
IODINE-123 (I-123)	100
IODINE-125 (I-125)	1
IODINE-126 (I-126)	1
IODINE-129 (I-129)	0.1
IODINE-131 (I-131)	1
IODINE-132 (I-132)	10
IODINE-133 (I-133)	1
IODINE-134 (I-134)	10

EXEMPT QUANTITIES

(INCLUDES NARM AND BY PRODUCT MATERIAL) – CONT.

IODINE-135 (I-135)	10
IRIDIUM-192 (Ir-192)	10
IRIDIUM-194 (Ir-194)	100
IRON-52 (Fe-52)	10
IRON-55 (Fe-55)	100
IRON-59 (Fe-59)	10
KRYPTON-85 (Kr-85)	100
KRYPTON-87 (Kr-87)	10
LANTHANUM-140 (La-140)	10
LUTETIUM-177 (Lu-177)	100
MANGANESE-52 (Mn-52)	10
MANGANESE-54 (Mn-54)	10
MANGANESE-56 (Mn-56)	10
MERCURY-197M (Hg-197m)	100
MERCURY-197 (Hg-197)	100
MERCURY-203 (Hg-203)	10
MOLYBDENUM-99 (Mo-99)	100
NEODYMIUM-147 (Nd-147)	100
NEODYMIUM-149 (Nd-149)	100
NICKEL-59 (Ni-59)	100
NICKEL-63 (Ni-63)	10
NICKEL-65 (Ni-65)	100
NIOBIUM-93M (Nb-93m)	10
NIOBIUM-95 (Nb-95)	10
NIOBIUM-97 (Nb-97)	10
OSMIUM-185 (Os-185)	10
OSMIUM-191M (Os-191m)	100
OSMIUM-191 (Os-191)	100
OSMIUM-193 (Os-193)	100
PALLADIUM-103 (Pd-103)	100
PALLADIUM-109 (Pd-109)	100
PHOSPHORUS-32 (P-32)	10
PLATINUM-191 (Pt-191)	100
PLATINUM-193M (Pt-193m)	100
PLATINUM-193 (Pt-193)	100

EXEMPT QUANTITIES

(INCLUDES NARM AND BY PRODUCT MATERIAL) - CONT.

PLATINUM-197M (Pt-197m)	100
PLATINUM-197 (Pt-197)	100
POLONIUM-210 (Po-210)	0.1
POTASSIUM-42 (K-42)	10
POTASSIUM-43 (K-43)	10
PRASEODIMIUM-142 (Pr-142)	100
PRASEODIMIUM-143 (Pr-143)	100
PROMETHIUM-147 (Pm-147)	10
PROMETHIUM-149 (Pm-149)	10
RHENIUM-186 (Re-186)	100
RHENIUM-188 (Re-88)	100
RHODIUM-103M (Rh-103m)	100
RHODIUM-105 (Rh-105)	100
RUBIDIUM-81 (Rb-81)	10
RUBIDIUM-86 (Rb-86)	10
RUBIDIUM-87 (Rb-87)	10
RUTHENIUM-97 (Ru-97)	100
RUTHENIUM-103 (Ru-103)	10
RUTHENIUM-105 (Ru-105)	10
RUTHENIUM-106 (Ru-106)	1
SAMARIUM-151 (Sm-151)	10
SAMARIUM-153 (Sm-153)	100
SCANDIUM-46 (Sc-46)	10
SCANDIUM-47 (Sc-47)	100
SCANDIUM-48 (Sc-48)	10
SELENIUM-75 (Se-75)	10
SILICON-31 (Si-31)	100
SILVER-105 (Ag-105)	10
SILVER-110M (Ag-110m)	1
SILVER-111 (Ag-111)	100
SODIUM-22 (Na-22)	10
SODIUM-24 (Na-24)	10
STRONTIUM-85 (Sr-85)	10
STRONTIUM-89 (Sr-89)	1
STRONTIUM-90 (Sr-90)	0.1

EXEMPT QUANTITIES

(INCLUDES NARM AND BY PRODUCT MATERIAL) – CONT.

STRONTIUM-91 (Sr-91)	10
STRONTIUM-92 (Sr-92)	10
SULPHUR-35 (S-35)	100
TANTALUM-182 (Ta-182)	10
TECHNETIUM-96 (Tc-96)	10
TECHNETIUM-97M (Tc-97m)	100
TECHNETIUM-97 (Tc-97)	100
TECHNETIUM-99M (Tc-99m)	100
TECHNETIUM-99 (Tc-99)	10
TELLURIUM-125M (Te-125m)	10
TELLURIUM-127M (Te-127m)	10
TELLURIUM-127 (Te-127)	100
TELLURIUM-129M (Te-129m)	10
TELLURIUM-129 (Te-129)	100
TELLURIUM-131M (Te-131m)	10
TELLURIUM-132 (Te-132)	10
TERBIUM-160 (Tb-160)	10
THALLIUM-200 (Tl-200)	100
THALLIUM-201 (Tl-201)	100
THALLIUM-202 (Tl-202)	100
THALLIUM-204 (Tl-204)	10
THULIUM-170 (Tm-170)	10
THULIUM-171 (Tm-171)	10
TIN-113 (Sn-113)	10
TIN-125 (Sn-125)	10
TUNGSTEN-181 (W-181)	10
TUNGSTEN-185 (W-185)	10
TUNGSTEN-187 (W-187)	100
VANADIUM-48 (V-48)	10
XENON-131M (Xe-131m)	1,000
XENON-133 (Xe-133)	100
XENON-135 (Xe-135)	100
YTTERBIUM-175 (Yb-175)	100
YTTRIUM-87 (Y-87)	10
YTTRIUM-90 (Y-90)	10

EXEMPT QUANTITIES

(INCLUDES NARM AND BY PRODUCT MATERIAL) – CONT.

YTTRIUM-91 (Y-91)	10
YTTRIUM-92 (Y-92)	100
YTTRIUM-93 (Y-93)	100
ZINC-65 (Zn-65)	10
ZINC-69M (Zn-69m)	100
ZINC-69 (Zn-69)	1,000
ZIRCONIUM-93 (Zr-93)	10
ZIRCONIUM-95 (Zr-95)	10
ZIRCONIUM-97 (Zr-97)	10
ANY RADIOACTIVE MATERIAL NOT LISTED ABOVE OTHER THAN ALPHA EMITTING RADIOACTIVE MATERIAL.	0.1

TABLE 4
ACCEPTABLE SURFACE CONTAMINATION LEVELS

U-NAT, U-235, U-238, AND ASSOCIATED DECAY PRODUCTS	AVERAGE: 5,000 dpm alpha/100 cm ² MAXIMUM: 15,000 dpm alpha/100 cm ² REMOVABLE: 1,000 dpm alpha/100 cm ²
TRANSURANICS, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	AVERAGE: 100 dpm/100 cm ² MAXIMUM: 300 dpm/100 cm ² REMOVABLE: 20 dpm/100 cm ²
Th-NAT, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	AVERAGE: 1,000 dpm/100 cm ² MAXIMUM: 3,000 dpm/100 cm ² REMOVABLE: 200 dpm/100 cm ²
BETA-GAMMA EMITTERS (NUCLIDES WITH DECAY MODES OTHER THAN ALPHA EMISSION OR SPONTANEOUS FISSION) EXCEPT Sr-90 AND OTHERS NOTED ABOVE (SEE NOTE 7).	AVERAGE: 5,000 dpm beta-gamma/100 cm ² MAXIMUM: 15,000 dpm beta-gamma/100cm ² REMOVABLE: 1,000 dpm beta-gamma/100cm ²

NOTES:

1. Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.
2. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
3. Measurements of average contaminant should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each such object.
4. The maximum contamination level applies to an area of not more than 100 cm².
5. The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped. Except for transuranics and Ra-226, Ra-228, Ac-227, Th-228, Th-230 and Pa-231 alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

6. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hour at one centimeter and 1.0 mrad/hour at one centimeter, respectively, measured through not more than seven milligrams per square centimeter of total absorber.

7. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

TABLE 5
TRANSPORTATION REGULATIONS
49 CFR

1. TYPE A PACKAGES

173.24	Standard Requirements for All Packages
173.411	General Design Requirements
173.412	Additional Design Requirements for Type A Packages
173.415(a)	Authorized Type A Packages
173.461	Demonstration of Compliance with Tests
173.462	Preparation and Specimens for Testing
173.463	Packaging and Shielding – Testing for Integrity
173.465	Type A Packaging Tests
173.466	Additional Tests for Type A Packagings Designed for Liquids and Gases
173.474	Quality Control for Construction of Packaging
173.475	Quality Control Requirements Prior to Each Shipment of Radioactive Material
178.350	Specification 7A; General Packaging, Type A

2. EXCEPTIONS TO TYPE A SPECIFICATION REQUIREMENTS

173.421	Limited Quantities of Radioactive Material
173.422	Exceptions for Instruments and Articles
173.423	Table of Activity Limits – Excepted Quantities and Articles
173.424	Excepted Articles Containing Natural Uranium or Thorium
173.425	Transport Requirements for Low Specific Activity (LSA) Radioactive Material

3. PACKAGING LIMITATIONS

173.441	Radiation Level Limitations
173.442	Thermal Limitations
173.443	Contamination Control

4. MISCELLANEOUS REQUIREMENTS

172 Sub C	Shipping Papers
172 Sub D	Marking
172.301	General Marking Requirements

172.304	Marking Requirements
172.306	Consignee's or Consignor's Name and Address
172.310	Radioactive Materials
172.403	Radioactive Material – Labeling
172.444	Labeling Requirements
172. 504	General Placarding Requirements
172.506	Providing and Affixing Placards: Highway
172.519	General Specifications for Placards
172.556	Radioactive Placard
173.446	Placarding Requirements
173.1	Purpose and Scope – Training
173.22	Shipper's Responsibility
173.447	Storage Incident to Transportation – General Requirements

TABLE 6**DETERMINATION OF QUANTITY LIMITS AND PACKAGE SELECTION**

10 CFR 71 and 49 CFR 173 use A_1 and A_2 values for quantity limitations for every radionuclide. The A_1 and A_2 values in curies are the maximum activity that may be transported in a Type A package. Quantities exceeding the limits require Type B packaging. The table below provides frequently encountered radionuclides. See 10 CFR 71, Appendix A or 49 CFR 173.435 for a complete listing.

The A_1 and A_2 values are also used to determine exceptions to Type A packaging (49 CFR 173.421–425). See Table 2.8–C. Quantities less than table packaging values are excepted from much of the specification packaging, marking, and labelling.

**TYPE A PACKAGE QUANTITY LIMITS FOR
SELECTED RADIONUCLIDES
(ADDITIONAL RADIONUCLIDES ARE LISTED IN 49 CFR 173.435)**

<u>SYMBOL OF RADIONUCLIDE</u>	<u>ELEMENT AND ATOMIC NUMBER</u>	<u>A_1 (Ci) (SPECIAL FORM)</u>	<u>A_2 (Ci) (NORMAL FORM)</u>
C-14	Carbon (6)	1000	60
Cs-137	Cesium (55)	30	10
Mo-99	Molybdenum (42)	100	20
U-235	Uranium (92)	100	0.2
Ra-226	Radium (88)	10	0.05
Pb-210	Lead (82)	20	20
Ir-192	Iridium (77)	20	10
Pm-147	Promethium (61)	1000	25
Sr-90	Strontium (38)	10	0.4
Co-60	Cobalt (27)	7	7
H-3	Hydrogen (1) (Activated luminous paint)	1000	1000

BLANK

TABLE 7

**ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS AND ARTICLES
(49 CFR 173.421-425)**

NATURE OF CONTENTS*	INSTRUMENT AND ARTICLE LIMITS	INSTRUMENT AND ARTICLE PACKAGE LIMITS	MATERIALS PACKAGE LIMITS
SOLIDS			
Special Form	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Other Forms	$10^{-2}A_2$	A_2	$10^{-3}A_2$
LIQUIDS			
Tritiated Water			
<0.1 Ci/l	—	—	1,000 curies
0.1 Ci-1.0 Ci/l	—	—	100 curies
>1.0 Ci/l	—	—	1 curie
Other Liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
GASES			
Tritium**	20 curies	200 curies	20 curies
Special Form	$10^{-3}A_1$	$10^{-1}A_1$	$10^{-3}A_1$
Other Forms	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

* For mixture of radionuclides, see 49 CFR 173.433(b).

** These values also apply to tritium in activated luminous paint and tritium absorbed in solid carriers.

BLANK

T7-2

TABLE 8
RASP USAGE CODE INSPECTION FREQUENCIES

USAGE CODE	DESCRIPTION	MINIMUM INSPECTION FREQUENCY (YEARS)
A	GAMMA RADIOGRAPHY	1
B	GENERAL INDUSTRIAL	3
C	CALIBRATOR (> 100 Ci)	3
D	ENVIRONMENTAL	2
E	TYPE A BROAD SCOPE	2
F	TYPE B BROAD SCOPE	3
G	TYPE C BROAD SCOPE	5
H	SPECIAL NUCLEAR MATERIAL (LESS THAN CRITICAL MASS)	2
I	PORTABLE GAUGES	4
J	ANALYTICAL MEASURING INSTRUMENTS	6
K	GAS CHROMATOGRAPHS	7
L	DEPLETED URANIUM MUNITIONS TESTING (OUTDOORS)	3
	DEPLETED URANIUM MUNITIONS TESTING (INDOORS)	7
M	SUBCRITICAL ASSEMBLIES	6
N	RADIOISOTOPE THERMOELECTRIC GENERATOR POWER SOURCES	7
P	FIXED GAUGES	7
Q	IRRADIATORS	3
R	BURIED WASTE	7
S	SOURCE MATERIAL	3
T	RADIOACTIVE COMMODITIES (HANDLING AND STORAGE)	3
U	RESERVED	
V	SPECIAL NUCLEAR MATERIAL (LESS THAN 200 GRAMS)	6
W	RESEARCH	3
X	CALIBRATOR (< 100 Ci)	7
Y	RESERVED	
Z	RESERVED	
AA	ANALYTICAL MEASUREMENT INSTRUMENTS (MACHINE SOURCES)	6

USAGE CODE	DESCRIPTION	MINIMUM INSPECTION FREQUENCY (YEARS)
BB	X-RAY RADIOGRAPHY	3
CC	ACCELERATORS	3
DD	RADIUM REMOVAL	3
ZZ	RADIATION HEALTH	*

* The Radiation Health Program shall be inspected in conjunction with each RASP Usage as it applies to that particular usage.

TABLE 9
COMMONLY USED RADIONUCLIDES

ISOTOPE	RADIATION*	COMMON USE**
Radium (Ra-226)	A, B, G	Luminescent Paint
Strontium (Sr-90)	B	Luminescent Paint
Tritium (H-3)	B	Luminescent Paint
Promethium (Pm-147)	B	Luminescent Paint
Krypton (Kr-85)	B, G	Luminescent Paint
Cobalt (Co-60)	B, G	Electron Tubes
Cesium (Cs-137)	B, G	Electron Tubes
Thorium (Th-232)	A, B, G	Aircraft Components
Depleted Uranium (U-238)	A, B, G	Counterweights

* Principal radiation emissions. A = alpha, B = beta, G = gamma.

** Each of the isotopes listed has been used in a variety of applications. The listed use is the one most commonly encountered in radioactive material removal operations.

BLANK

TABLE 10

RADIONUCLIDES IN NSN-NUMBERED COMMODITIES

RADIONUCLIDE AND SOURCES	HALF-LIFE	ENERGY (MeV)			MEANS OF DETECTION*
		GAMMA	BETA	ALPHA	
AMERICIUM-241 (Am-241) Ionization Devices and Alarms (Ex: Smoke Detectors)	432 yrs.	0.059 0.026 0.863	None	5.44 5.49	2, 4
CADMIUM-109 (Cd-109) Analytical Devices	1.3 yrs.	0.088	None	None	3
CARBON-14 (C-14) Electronic Devices	5730 yrs.	None	0.156	None	Lab Only
CESIUM-137 (Cs-137) Electronic Devices, Ionization Devices, Electron Tubes	30.17 yrs.	0.662	0.512	None	1, 2, 3
COBALT-60 (Co-60) Electronic Devices, Ionization Devices	5. 27 yrs.	1.17 1.33	0.318	None	1, 2, 3
IRON-55 (Fe-55) Analytical Devices	2.7 yrs.	0.023	None	None	3
KRYPTON-85 (Kr-85) Luminescent Devices, Electronic Devices, Electron Tubes	10.72 yrs.	0.514	0.687	None	1, 2, 3
NICKEL-63 (Ni-63) Ionization Devices, Electronic Devices, Electron Tubes	100 yrs.	None	0.066	None	Lab Only
POLONIUM-210 (Po-210) Ionization Devices (Ex: static eliminators)	138.38 days	0.803	None	5.30	1, 2, 3, 4

RADIONUCLIDE AND SOURCES	HALF-LIFE	ENERGY (MeV)			MEANS OF DETECTION*
		GAMMA	BETA	ALPHA	
POTASSIUM-40 (K-40) Occurs Naturally in Chemicals Containing Potassium (Ex: fire extinguishers, fertilizers, lab chemicals)	1.25x10 ⁹ yrs.	1.46	1.33	None	1, 2, 3
PROMETHIUM-147(Pm-147) Luminescent Devices	2.62 yrs.	0.121	0.224	None	1, 2, 3
RADIUM-226 (Ra-226) Luminescent Devices,** Electron Tubes,** Electronic Devices (Ex: radar equipment), analytical devices, ionization devices, natural sources (Ex: paint, pigments, granite buildings)	1600 yrs.	0.186	None	4.78	1, 2, 3, 4
STRONTIUM-90 (Sr-90) Luminescent Devices, Electron Tubes	29 yrs.	None	0.546	None	1, 2
TECHNETIUM-99 (Tc-99) Ionization Devices	2.13x10 ⁵ yrs.	0.090	0.293	None	1, 2
THORIUM-232 (Th-232) Ionization Devices, TIG Welding Rods, Electron Tubes	1.4x10 ¹⁰ yrs.	0.059	None	3.95 4.01	1, 2, 3, 4
TRITIUM (Hydrogen-3) (T or H-3) Luminescent Devices	12.3 yrs.	None	0.019	None	Lab Only

RADIONUCLIDE AND SOURCES	HALF-LIFE	ENERGY (MeV)			MEANS OF DETECTION*
		GAMMA	BETA	ALPHA	
URANIUM-238 (U-238) Naturally Occurring (Ex: firebricks, building materials, ceramics), Munitions	4.468x10 ⁹ yrs.	0.496	None	4.15 4.196	1, 2, 3, 4

* MEANS OF DETECTION:

1. IM-247 Series (e.g., E-140N)
2. AN/PDR-27 or Equivalent
3. PRM-5N/SPA-3, GRM-595/GP-595 or IM-253/DT-640 Scintillation
Ratemeter Probe
4. AN/PDR-56 or Equivalent

** Luminescent devices containing radium-226 are obsolete and should be purged from the system.

BLANK

T10-4